OPERATING AND MAINTENANCE MANUAL
ANGLE POSITION INDICATOR
MODEL 8810

NAI TM 5017

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NOTE

This manual describes the Model 8810 and its various standard options. For special options, see addenda attached.

CAUTION

High voltage exists at several points in the instrument. Normal precautions consistent with good practice should be taken to reduce shock hazard.

A potential shock hazard exists when ungrounded power source or ungrounded case operation is employed. Persons operating the instrument should be made aware of and take precautions against this condition.

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SECTION 1

GENERAL DESCRIPTION

1 GENERAL

his manual contains general description, nstallation, operating instructions, main- enance and troubleshooting procedures, re- lacement parts lists, and schematic dia- rams for the Angle Position Indicator, odel 8810 (herein after referred to as PI).

2 PHYSICAL DESCRIPTION

he API (fig. 1-1) is a bench-top version f the rack-mounted model 8800 featuring ront panel controls and input terminals. he unit is furnished with feet and fold- way tilt stand. By using mounting brac- ets, the unit may be rack mounted. Brac- ets for half-rack mounting are included s standard equipment. Full rack flangs re available.

1.3 FUNCTIONAL DESCRIPTION

The API is an extension of the instrument product line using the exclusive LSI TRIG-LOGIC™ processor.

It is a full-tracking type II servo, which follows synchros or resolvers to speeds of 1000°/second without velocity errors. It accepts any standard line-to-line level without pre-selecting or pre-programming the input signals. The converted synchro or resolver data is presented in two forms:

- Front-panel display using planar gas discharge information displays
- BCD outputs on the rear panel connector

1.4 SPECIFICATIONS

Table 1-1 provides characteristics and specifications for the API.

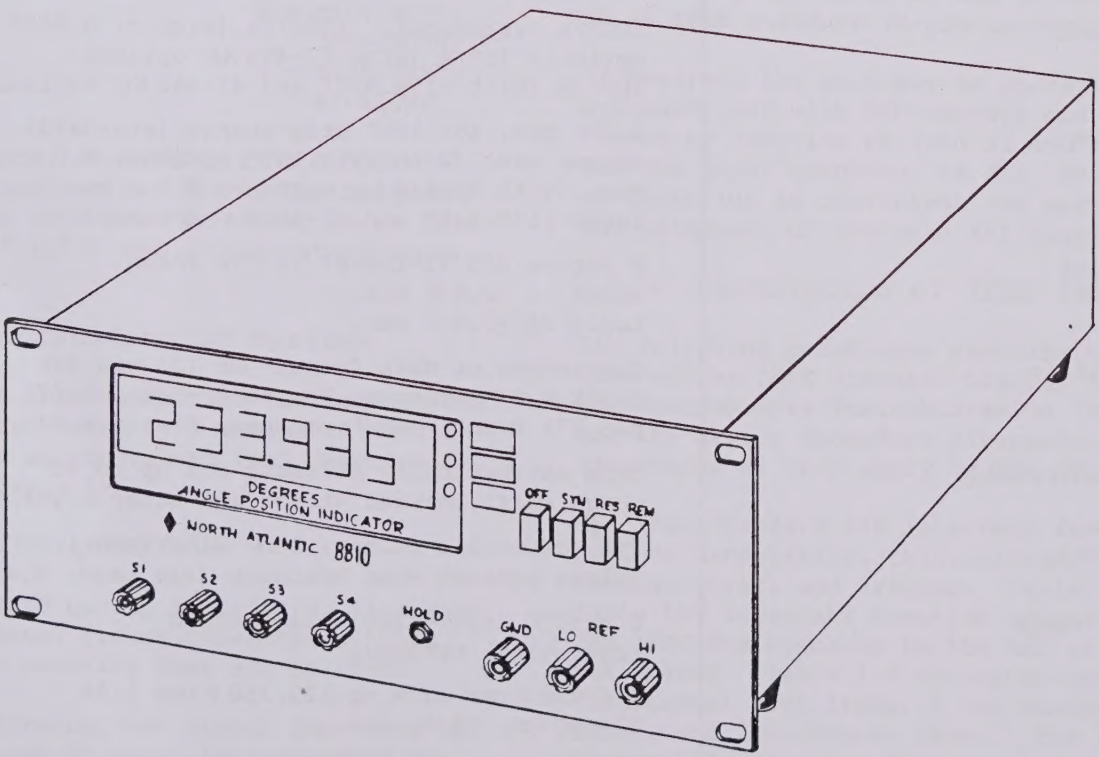


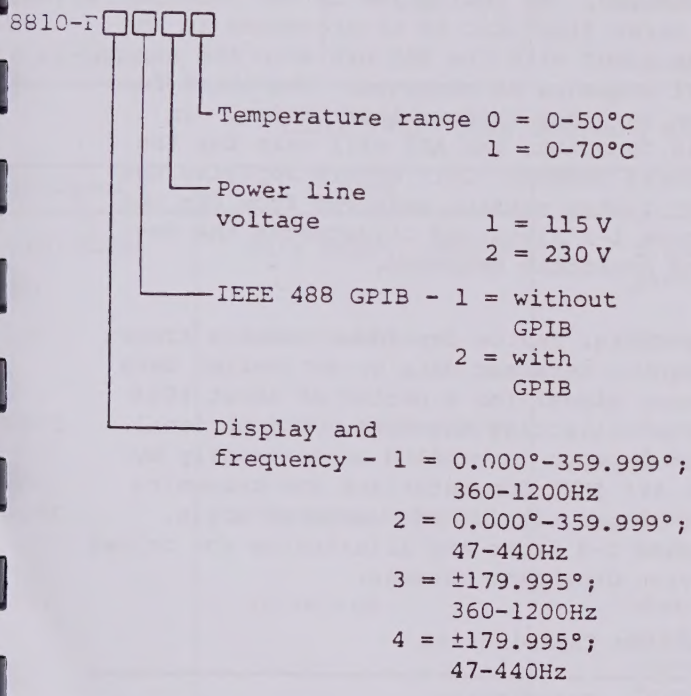
Figure 1-1. Angle Position Indicator

Table 1-1. Specifications

Item	Specification
Resolution	0.001° (0.005° with ±179.995° option)
Input channels	2
Signal inputs	
Channel 1	Synchro; 11.8, 26, or 90 V L-L auto ranging
Channel 2	Resolver; 11.8, 26, or 90 V L-L auto ranging
	(Non-standard input levels available; consult factory)
Accuracy (includes errors from all sources)	±0.004° (standard) ±0.010° (with ±179.995° option)
Frequency range	360-1200 Hz (standard); 47-440 Hz (optional)
Angular range	0.000° - 359.999° (standard); ±179.995° (optional)
Reference voltage	3 V to 115 V (AGC)
Input impedance	
Signal	1MΩ (min.)
Reference	100KΩ(min.)
Tracking speed	200°/s (standard); 1000°/s (with ±179.995° option); 75°/s (with 47-440 Hz option); 180°/s (with ±179.995° and 47-440 Hz options)
Settling time	1.5 s max. for 180° step change (standard); 400 ms max. (with ±179.995° option); 3.0 s max. (with 47-440 Hz option); 1.5 s max. (with ±179.995° and 47-440 Hz options)
Digital output	6 decade BCD (1-2-4-8) 10 TTL loads Logic 1: +2.5 V min. Logic 0° +0.6 V max.
Data availability	Continuous or data freeze; DF (J1 pin 42) track = 0 V or open; freeze = +5 V; $\overline{DF}$ (J1 pin 27) track = +5 V or open; freeze = 0 V
Auto phase correction	Unit automatically corrects for up to 30° phase shift between stator and rotor signals.
Converter busy	TTL compatible pulses, 1 µs wide (nom.); pulses present when tracking (see para. 3.4.2)
Temperature range	0 - 50°C (operating) standard; 0 - 70°C (operating) optional
Input power	115/230 V rms ±10% or 125/350 V rms ±10% 47-440 Hz; 25 VA max.
Mating connector	P/N 783718

1.5 CONFIGURATION

The Model 8810 is available in various configurations. Order a Model 8810 by specifying the model followed by a four-digit number as follows:


8810-F□□□□
Temperature range 0 = 0-50°C
1 = 0-70°C
Power line voltage 1 = 115 V
2 = 230 V
IEEE 488 GPIB - 1 = without GPIB
2 = with GPIB
Display and frequency - 1 = 0.000°-359.999°; 360-1200Hz
2 = 0.000°-359.999°; 47-440Hz
3 = ±179.995°; 360-1200Hz
4 = ±179.995°; 47-440Hz

For instance, 8810-F1211 is a 0.000°-359.999° unit with a 360-1200Hz frequency range, the IEEE interface bus, power line voltage of 115 V and a temperature range of 0-70°C.

1.5.1 Explanation of Options

Throughout this manual the various options are differentiated by a shortened description. For an equivalent full description, refer to table 1-2.

1.5.2 IEEE Interface

When the IEEE option is ordered, line cord, and rear panel ground connections, tilt stand, and mounting feet are deleted.

Power, reference, and signal input are applied through J5 which is a standard 50-pin input connector but does not contain the logic signals (BCD outputs, data freeze, and converter busy).

Table 1-2. Option Description

Short description	Full description
Standard	360-1200Hz, 0.001° resolution, 0-359.999° display
±180°	360-1200Hz, 0.005° resolution, ±179.995° display
Low frequency	47-440Hz, 0.001° resolution, 0-359.999° display
Low frequency, 0.005° resolution	47-440Hz, 0.005° resolution
IEEE	IEEE
High temperature	0-70°C temperature

The logic signals are connected to the IEEE board which interfaces with the external computer lines by way of J6 which is an IEEE standard 24-pin connector.

If desired, the unit may be operated as a standard, API with BCD outputs and data freeze by removing P1 from J1 and connecting the input connector to J1. This mode of operation is convenient for servicing and alignment of the main API board.

1.5.3 Description of IEEE Interface

The following paragraphs describe the function of the IEEE Standard Digital Interface for Programmable Instrumentation (488-1975) and the device dependent programming instructions as they apply to the API.

The IEEE Standard 488 interface functions include handshaking, talk, listen, service, remote, clear, and trigger. Table 1-3 lists the interface function capabilities. The IEEE Bus connects to the API on the rear panel. Table 1-4 describes the 8 bi-directional data lines, 5 bus management lines, and 3 handshake lines. The 31 talk-listen addresses are rear panel mounted. Table 1-5 lists their ASCII equivalents and table 1-6 describes the IEEE Bus commands.

he device dependent messages of the API re transmitted over the bus as ASCII characters. Both listener and talker device ependent messages require beginning and nding delimiters (see appropriate tables).

he listener device dependent message has he capability of programming three functions of the API. The first function is hannel selection; either channel 1 for ynchro or channel 2 for eresolver. The econd function is one of two measuring odes and interrupt capability. The tracking or normal mode allows the API to follow he input signal without interference. he freeze mode holds the present data until returned to the tracking mode. The alid mode provides the user with a service equest interrupt capability at the end of measuring cycle and should be used in onjunction with the tracking mode. The alid measuring cycle terminates as a result of one of the following: (1) With a table input signal and the converter busy ignal pulse period of more than 100 ms, ermination occurs, or (2) With an unstable nput signal and the converter busy signal pulse period of less than 100 ms, termination occurs after four seconds. For unstable data, during the periods the API has been addressed to talk or listen, the data readings are not checked or timed. Checking is resumed when the API is unaddressed. An indication in the form of an error flag (bit 8) is presented to the user along with the SRQ bit when the serial poll sequence is executed. The third function is group trigger instruction. In this function, the API will wait for the address command (GET) before applying the last listen message received from the bus. Figure 1-2 lists and illustrates the device dependent messages.

The talker device dependent message transmits the measured data by activating Data Freeze signal for a period of about 40µs while collecting the data. The optional 180° ouptput is handled automatically by the API IEEE Bus interface and transmits the proper sign of the measured angle. Figure 1-3 lists and illustrates the talker device dependent message.

Table 1-3. IEEE Interface Function Capabilities

nterface function	Subset	Description
ource Handshake	SH1	Complete capability to transfer data on the DIO lines properly.
ceptor Handshake	AH1	Complete capability to receive data from the DIO lines properly.
alker	T6	Capability to send device dependent messages (basic talker), service request status information (serial poll), and unaddress if My Listen Address (MLA) or any other talk address it true.
istener	L4	Capability to receive device dependent message or interface commands (basic listener) and unaddress if My Talk Address (MTA) is true.
xtended Talker	TEØ	No capability
xtended Listener	LEØ	No capability
ervice Request	SR1	Complete capability to asynchronously request service from controlling device.
emote Local	RL2	No local lockout capability

Table 1-3. IEEE Interface Function Capabilities (Continued)

Interface function	Subset	Description
Parallel POLL	PPØ	No capability
Device Clear	DC1	Complete capability to return the device to its defined clear state.
Device Trigger	DT1	Complete capability to start the measuring cycle.
Controller	CØ	No capability

Table 1-4. IEEE Standard Bus Signal Line Description

Signal	Name	Description
DI01-DI08	Data Input, Output	Eight bi-directional data lines used to carry bit-parallel, byte-serial messages.
DAV	Data Valid	When true, indicates valid data present on DIO lines.
NRFD	Not Ready for Data	When false (high), device is ready to accept data. When true (low) device is not ready to accept data.
NDAC	Not Data Accepted	When false (high), device has accepted data. When true (low) device has not accepted data.
ATN	Attention	When true (low), the DIO lines transmit in the command mode. The only valid data are addresses, unaddress commands and universal commands. When false (high), DIO lines transmit in the data mode (i.e., device dependent messages).
IFC	Interface Clear	Places the interface in a quiescent condition. All interface functions transfer to an idle state. The SRQ line is false and the interface unaddressed
SRQ	Service Request	When true (low), the API has completed a measuring cycle. By executing a serial poll sequence, the validity of the measured angle can be detected.
REN	Remote Enable	When true (low), the API is addressed and the front-panel REM push button depressed, the API will Respond to listener device dependent messages. When REM is false (high), the SRQ (Service Request) function is disabled. All other functions operate normally. When the front-panel SYN or RES switch is depressed, listener device dependent messages will not be accepted and the API is in local control. Listener device dependent messages received when the API is in local control will not be effective and will generate an SRQ (Service Request). The API will set bit 6 of its status byte to indicate it is in local control (table 1-5). Note the front-panel HOLD push button is disabled when REM is active.

Table 1-5. IEEE API Addressing

ddress switches				Talk	Listen
A4	A3	A2	A1		
0	0	0	0	@	SP
0	0	0	1	A	!
0	0	1	0	B	"
0	0	1	1	C	#
0	1	0	0	D	$
0	1	0	1	E	%
0	1	1	0	F	&
0	1	1	1	G	'
1	0	0	0	H	(
1	0	0	1	I	)
1	0	1	0	J	*
1	0	1	1	K	+
1	1	0	1	L	,
1	1	0	1	M	-
1	1	1	0	N	.
1	1	1	1	O	/

Address switches					Talk	Listen
A5	A4	A3	A2	A1		
1	0	0	0	0	P	Ø
1	0	0	0	1	Q	1
1	0	0	1	0	R	2
1	0	0	1	1	S	3
1	0	1	0	0	T	4
1	0	1	0	1	U	5
1	0	1	1	0	V	6
1	0	1	1	1	W	7
1	1	0	0	0	X	8
1	1	0	0	1	Y	9
1	1	0	1	0	Z	:
1	1	0	1	1	[	;
1	1	1	0	0	\	<
1	1	1	0	1	]	=
1	1	1	1	0	^	>

Table 1-6. IEEE Standard 488 Bus Commands

Commands	ASCII character	Definition
address		
Unlisten (UNL)	(?)	Unaddress all listeners presently addressed.
Untalk (UNT)	(-)	Unaddress current talker. Addressing an unused talker will also clear bus of all talkers, i.e., only one talker may be addressed to transmit at a time.
iversal		
Device Clear (DCL)	(DC4)	Return all devices on the bus to their cleared condition. The API will select CH1 (synchro) and tracking as the cleared condition, and stop any SRQ (Service Request) in progress. Otherwise DCL will act only on the device, whereas IFC will act only on the functions of the IEEE standard interface.
Serial Poll Enable (SPE)	(CAN)	Enables a serial poll sequence. Requires API to provide a status byte including the service request bit (DI07) when addressed to talk. Status bit — Description DI08 — Error, not stable when set DI07 — RQS, Request Service, when set DI06 — REM switch off, Local control, when set DI05 — Not used DI04 — Not used DI03 — Not used DI02 — Freeze when set; track when cleared DI01 — Resolver when set; synchro when cleared

Table 1-6. IEEE Standard 488 Bus Commands (Continued)

Commands	ASCII character	Definition
Serial Poll Disable (SPD)	(EM)	Disables serial poll sequence.
Addressed		
Group Execute Trigger (GET)	(BS)	Initiates measuring cycle of API when addressed. The listen program message must include group trigger G in order for the API interface to wait for the GET command before applying the present listen message. The GET command will always apply the last listen message when sent.
Selected Device Clear (SDC)	(EOT)	Returns API, when addressed to listen to the cleared condition as described for DCL above.

1. Beginning Delimiter

   > greater than sign

2. Functions

   A. Channel selection

      (1) S CH 1 synchro
      (2) R CH 2 resolver

   B. Tracking

      (1) T Tracking
      (2) F Freeze Data
      (3) V Valid (request service when measuring cycle ends)

   C. Group trigger

      (1) G Group Execute Trigger (wait for GET)

3. Message Terminator

   CRLF Carriage Return, Line Feed

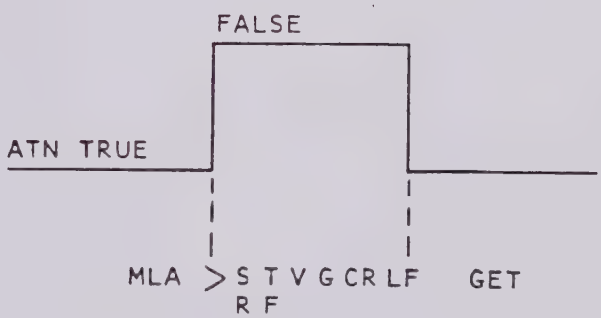


Figure 1-2. API Listener Device Dependent Messages

1. Delimiter

   < less than sign

2. Polarity (Option -01, ±180° only)

   A. + positive sign (angle from 000.000° to 179.995°)

   B. - negative sign (angle from 180.000° to 359.995°)

3. Data

   A. Ø-9 decimal characters

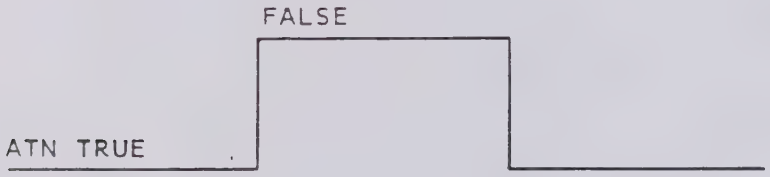
NOTES

(1) Data is measured in thousandths of degrees. For unit with the .005° res., the least significant character is measured in five thousandths of degrees.

(2) The data format for API's without the 180° option omits the polarity character and the most significant character will read from Ø to 3.

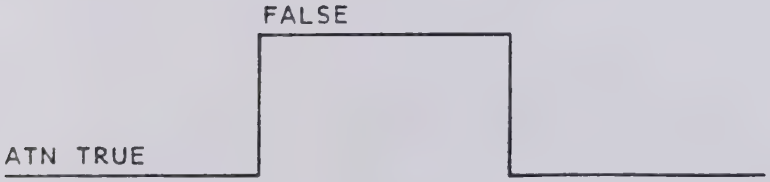
4. Message Terminator

   CRLF Carriage Return, Line Feed



MTA < XXXXXX CRLF

STANDARD API



MTA < ±XXXXXX CRLF

180° API

Figure 1-3. Talk Device Dependent Message

SECTION 2
INSTALLATION

2.1 GENERAL

This section provides instructions for unpacking, inspecting, and installing the API.

2.2 UNPACKING AND INSPECTION

This instrument has been thoroughly tested, inspected, and evaluated at the factory before shipment. Care has been taken in the design of the wrapping and packaging material to insure no damage results from mishandling.

Inspect the instrument externally. Check the front panel for signs of damage to the switches and display. Check the switches for smooth operation. Switch buttons should be secure. Check the condition of the connector and fuse on the back panel. Check covers for damage and loose screws. If the instrument passes this inspection, install it and place it in operation. If damage is found, refer to the Warranty in the back of the manual.

2.3 INSTALLATION

2.3.1 Mounting Instructions

The API may be mounted on a bench, using mounting brackets, or in standard rack, in any physical position. It requires no special cooling equipment. Mount the unit so that air flows freely around it, particularly the rear panel used to transmit the power supply heat to the ambient. Figure 2-1 provides outline dimensions for the API.

2.3.2 Cabling Instructions

System interconnection to the S/D is through rear panel connector J1. Pin designations are given in table 2-1.

2.3.3 Cabling Instructions for IEEE Interface

Connection to 115 V or 230 V rms power source is made through rear connector J5. Table 2-2 gives pin designations for J5.

Table 2-1. J1 Pin Designations

Pin	Function
1	Power input Hi
2	Power input Lo
3	Case ground
4	Digital ground
5	S1 } Synchro
6	S2 } Synchro
7	S3 } Synchro
8	Not used
9	R1 } Synchro ref
10	R2 } Synchro ref
11	Converter busy
12	0.04° } BCD outputs
13	0.01° } BCD outputs
14	0.8° } BCD outputs
15	0.2° } BCD outputs
16	4° } BCD outputs
17	1° } BCD outputs
18	Not used
19	Spare
20	$\overline{\text{REM}}$
21	S1 } Resolver
22	S2 } Resolver
23	S3 } Resolver
24	S4 } Resolver
25	R1 } Resolver ref
26	R2 } Resolver ref
27	Data freeze ($\overline{\text{DF}}$)
28	0.02° } BCD outputs
29	0.08° } BCD outputs
30	0.1° } BCD outputs
31	0.4° } BCD outputs
32	2° } BCD outputs
33	8° } BCD outputs
34	Not used
35	Not used
36	Spare
37	Spare
38	0.008°* } BCD outputs
39	0.002°* } BCD outputs
40	0.001°* } BCD outputs
41	Spare
42	Data freeze (DF)
43	Remote program
44	0.004°* } BCD outputs
45	20° } BCD outputs
46	40° } BCD outputs
47	80° } BCD outputs
48	10° } BCD outputs

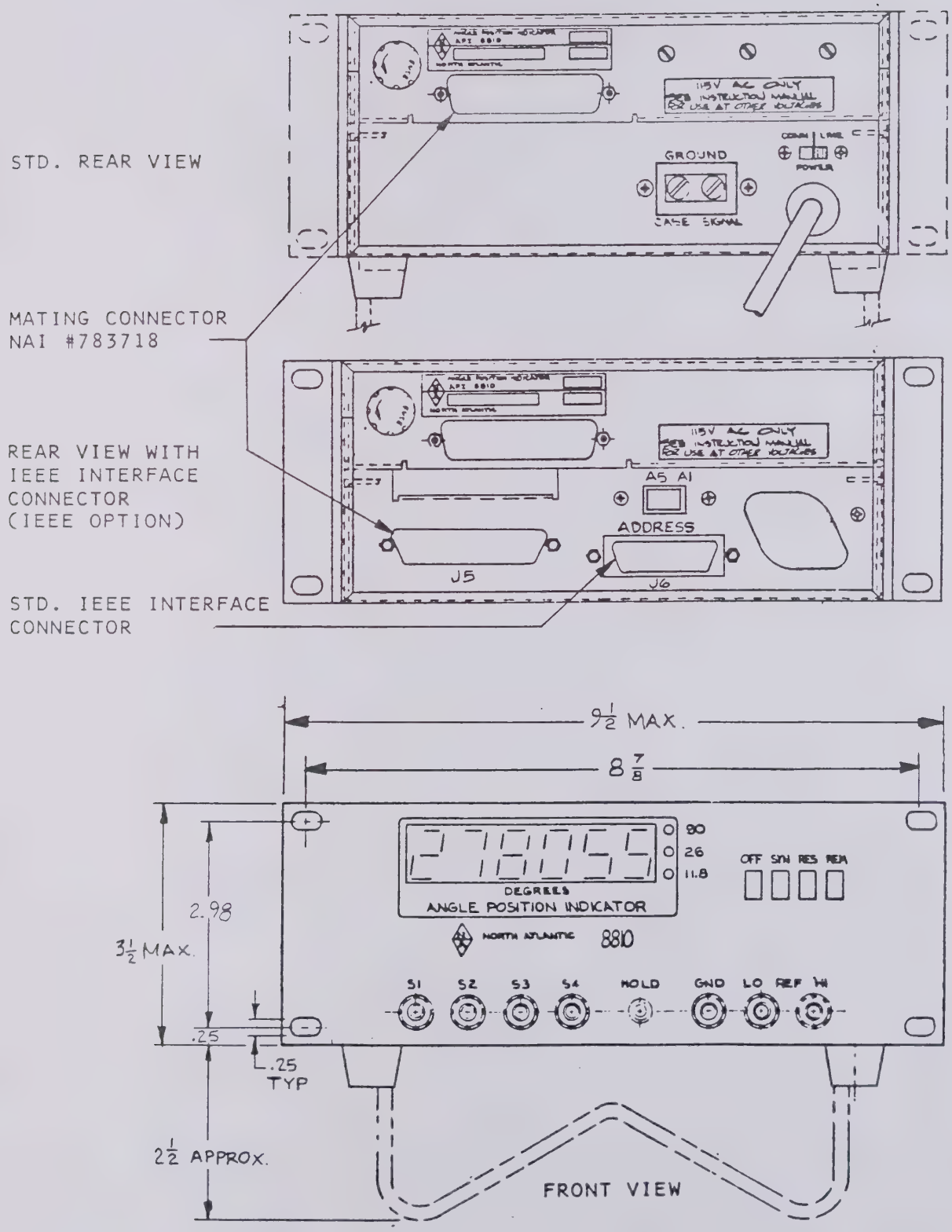


Figure 2-1. API Outline Drawing (Sh. 1 of 2)

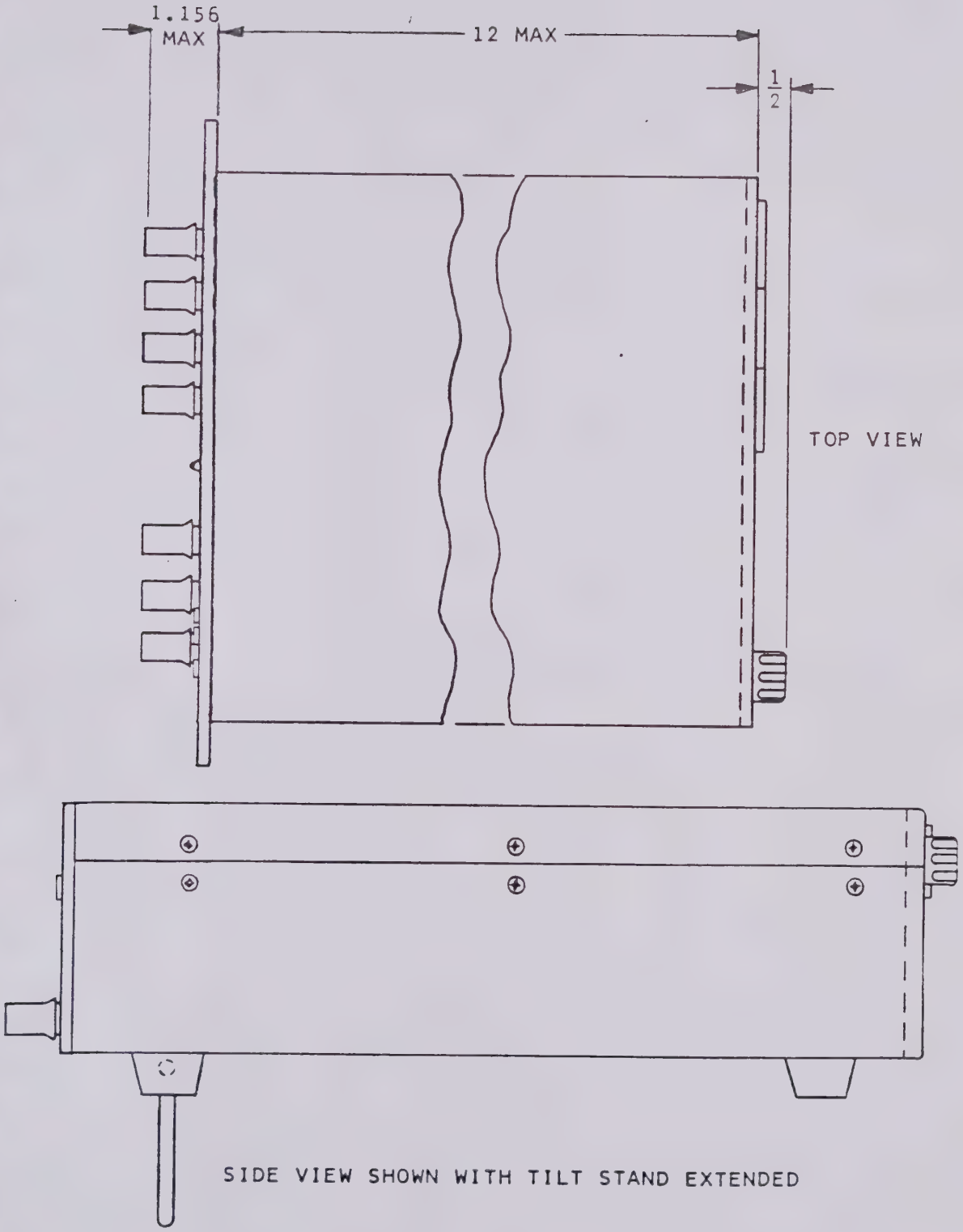


Figure 2-1. API Outline Drawing (Sh. 2 of 2)

able 2-1. J1 Pin Designations (Continued)

Pin	Function
49	100
50	200 ** BCD outputs

On 0.005 resolution units, pins 40 and 44 are connected internally and act as the 0.005 bit. Pins 38 and 39 are grounded at logic 0.
+bit (±180° option)

ignal and reference inputs may be connected o the front panel binding posts or the rear onnector J1.

onnection to reference and to synchro or esolver inputs may optionally be through onnector J5. Refer to tables 2-2 and 2-3 or J5 and J6 pin designations, respectively. able 2-4 and 2-5 provide interconnection ata between the IEEE interface and the API nd between the IEEE interface and the DIP witch on the lower chassis, respectively.

bserve the synchro and resolver conventions nd the grounding instructions.

able 2-2. J5 Pin Designations (IEEE)

Pin	Function
1	Power input Hi
2	Power input Lo
3	Case ground
4	Digital ground
5	S1
6	S2 Synchro
7	S3
8	Spare
9	R1 Synchro ref
10	R2
11	
12	
13	
14	Do not use
15	
16	
17	
18	
19	Spare
20	Spare
21	S1
22	S2 Resolver
23	S3
24	S4
25	R1 Resolver ref
26	R2

Table 2-2. J5 Pin Designations (IEEE) (Continued)

Pin	Function
27	
28	
29	
30	
31	Do not use
32	
33	
34	
35	
36	Spare
37	Spare
38	
39	
40	
41	
42	
43	
44	Do not use
45	
46	
47	
48	
49	
50	

Table 2-3. J6 Pin Designations (IEEE)

Pin	Function
1	DIO1
2	DIO2
3	DIO3
4	DIO4
5	EOI
6	DAV
7	NRFD
8	NDAC
9	IFC
10	SRQ
11	ATN
12	Shield
13	DIO5
14	DIO6
15	DIO7
16	DIO8
17	REN
18	Gnd., DAV
19	Gnd., NRFD
20	Gnd., NDAC
21	Gnd., IFC
22	Gnd., SRQ
23	Gnd., ATN
24	Gnd., Logic

Table 2-4. Interconnection Between IEEE and API

Connection	IEEE board	Rear panel	Function
U17-9	J1-1	J6-1	DI01
U17-15	J1-2	J6-2	DI02
U17-7	J1-3	U6-3	DI03
U17-2	J1-4	J6-4	DI04
U12-15	J1-5	J6-5	E01
U13-9	J1-6	J6-6	DAV
U12-9	J1-7	J6-7	NRFD
U12-7	J1-8	J6-8	NDAC
U13-15	J1-9	J6-9	IFC
U12-2	J1-10	J6-10	SRQ
U13-2	J1-11	J6-11	ATN
Chassis GND	J1-12	J6-12	Shield
U16-9	J1-18	J6-13	DI05
U16-15	J1-19	J6-14	DI06
U16-7	J1-20	J6-15	DI07
U16-2	J1-21	J6-16	DI08
U13-7	J1-22	J6-17	REN
GND	J1-23	J6-18	GND, DAV
GND	J1-24	J6-19	GND, NRFD
GND	J1-25	J6-20	GND, NDAC
GND	J1-26	J6-21	GND, IFC
GND	J1-27	J6-22	GND, SRQ
GND	J1-28	J6-23	GND, ATN
GND	J1-29	J6-24	GND, Logic

Table 2-5. Interconnection Between IEEE and DIP Switch

Connection	IEEE board	Address switch	Function
U3-5	J1-13	5	$\overline{\text{ADR5}}$
U18-9	J1-14	4	$\overline{\text{ADR4}}$
U18-12	J1-15	3	$\overline{\text{ADR3}}$
U18-2	J1-16	2	$\overline{\text{ADR2}}$
U18-5	J1-17	1	$\overline{\text{ADR1}}$
GND	J1-30 thru -33	NC	-
GND	J1-34	S (common)	-

3.4 Grounding

a high-accuracy synchro/resolver-to-dig-
al converter it is necessary for both
assis and signal ground to be tied toget-
r. Ground loops should be avoided in sys-
m applications. For this reason, chassis
ound pin 3 and signal ground pin 4 are
ought out separately and are also avail-
le at terminals on the rear panel.

bench applications, pins 3 and 4 should
tied together and connected to the low
de of the signal source to the synchro
resolver.

system applications, the separate pins
ke connections in other parts of the sys-
m possible. When not used, tie them to-
ther at the connector.

3.5 Signal Inputs

e API is designed to accept both synchro
d resolver inputs through the rear con-
ctor (J1). See table 2-6 for signal input
nnections and pin programming.

2.3.6 Internal Power Connections

The API is designed to operate from 115 V or 230 V, 47 to 440 Hz input power. It is normally set in the factory for 115 V operation. For 230 V operation move Power switch (fig. 2-2), located on the standard board near the power transformer, to 230 V position. For 125 V or 230 V operation, see schematic.

Table 2-6. Signal Inputs and Programming

Signal	Signal input	J1 pin
Synchro	S1	5
	S2	6
	S3	7
Synchro reference	R1	9
	R2	10
Resolver	S1	21
	S3	23
	S2	22
	S4	24
Resolver reference	R1	25
	R2	26

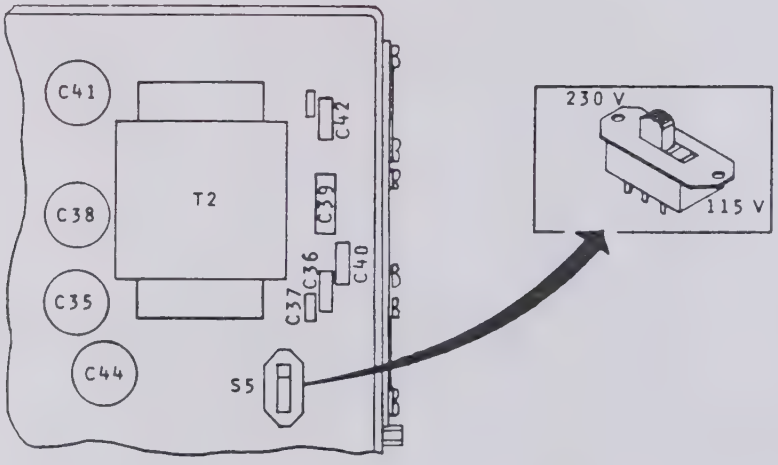


Figure 2-2. Power Programming

SECTION 3

OPERATION

3.1 GENERAL

This section provides operating procedures for the API.

3.2 SYNCHRO AND RESOLVER CONVENTIONS

Conventions for polarities, terminal designation, and direction of shaft rotation for synchros and resolvers are most frequently defined in accordance with military specifications MIL-S-20708 (synchros) and MIL-R-2153 (resolvers). The unit is provided with terminal designations and electrical characteristics to these specifications. In applying the conventions, exercise caution that:

- The manufacturer of the synchro or resolver has followed the MIL specification.
- The system use has not dictated a change in convention for a different characteristic (i.e., direction reversal or angular offset).

3.2.1 Synchro Transmitter Conventions

$$E(S1-S3) = -NE(R1-R2)\sin\theta$$
$$E(S3-S2) = -NE(R1-R2)\sin(\theta+120°)$$
$$E(S2-S1) = -NE(R1-R2)\sin(\theta+240°)$$

Where E(S1-S3) is the stator voltage S1 with respect to S3. Other stator and rotor voltages are similarly defined. N is the ratio of the maximum voltage across a pair of stator terminals to the voltage across the rotor terminals. θ is the shaft angle displacement from electrical zero which satisfies these equations. A schematic of the synchro transmitter is shown in figure 3-1.

3.2.2 Resolver Transmitter Conventions

For rotor energized resolvers:

$$E(S1-S3) = NE(R1-R3)\cos\theta - NE(R2-R4)\sin\theta$$
$$E(S2-S4) = NE(R2-R4)\cos\theta + NE(R1-R3)\sin\theta$$

A rotor energized resolver transmitter sche-

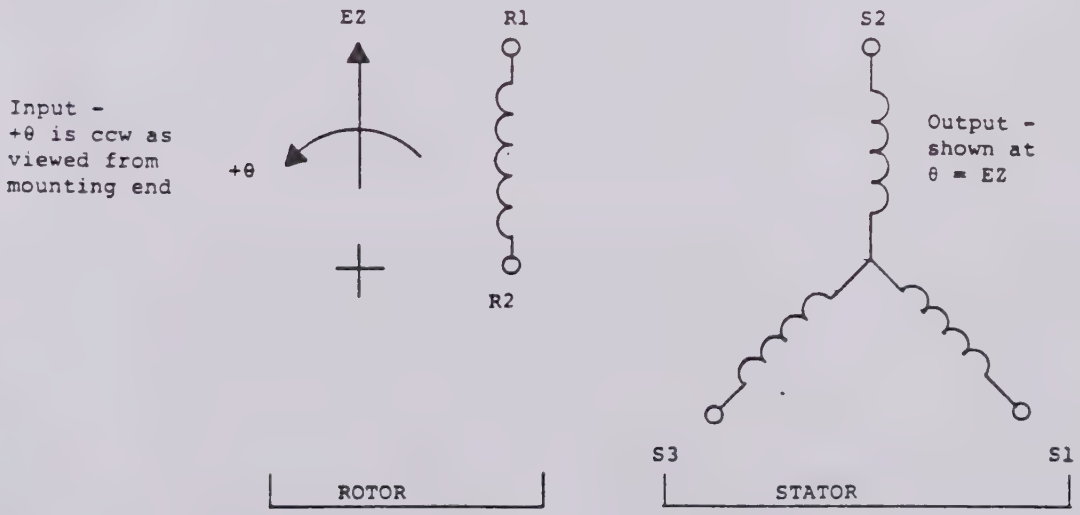


Figure 3-1. Synchro Transmitter, Schematic

atic is shown in figure 3-2. Input and utput may be reversed for stator energized devices.

ince the NAI standard assumes an R2-Hi and 4-Lo energized resolver, the resolver oututs become:

$$E(S1-S3) = -NE\ (R2-R4)\ \text{Sin}\ \theta$$
$$E(S2-S4) = +NE\ (R2-R4)\ \text{Cos}\ \theta$$

3.3 CONTROLS AND INDICATORS

The controls and indicators for the API are described in table 3-1 and illustrated in figure 3-3.

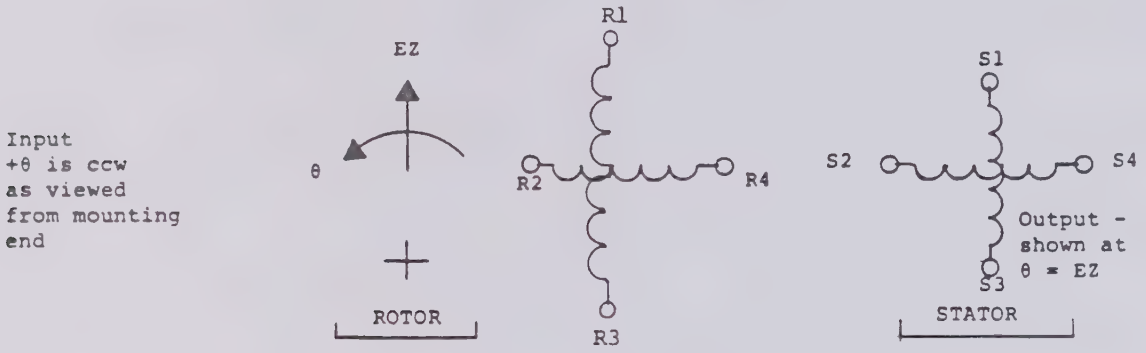


Figure 3-2. Resolver Transmitter, Schematic

Table 3-1. Controls and Indicators

Control or indicator	Function
OFF push button	Turns power off.
SYN push button	Selects synchro operation and turns on power.
RES push button	Selects resolver operation and turns on power.
REM push button	Allows remote programming of synchro or resolver operation via IEEE interface and turns on power.
Indicator	Displays angular information in degrees and decimal degrees.
HOLD momentary push button	When pushed in, freezes display.
115 V - 230 V Power switch (located on main chassis)	Allows unit to operate from either 115 V or 230 V power source.
EXT-INT Reference switch (located on main chassis)	Provides a means of switching reference as required in calibration procedure. Normally is set to INT.
90 V LED	When lit, indicates that input signal is 90 V L-L.
26 V LED	When lit, indicates that input signal is 26 V L-L.
11.8 V LED	When lit, indicates that input signal is 11.8 V L-L.
S1, S2, S3, S4 terminals	Accepts synchro or resolver input data.
HI, LO REF terminals	Accepts input reference voltage.
GND terminal	Chassis ground.
POWER switch (rear panel)	Transfers power input to rear-panel connector J1 for use in rack-mounted units.

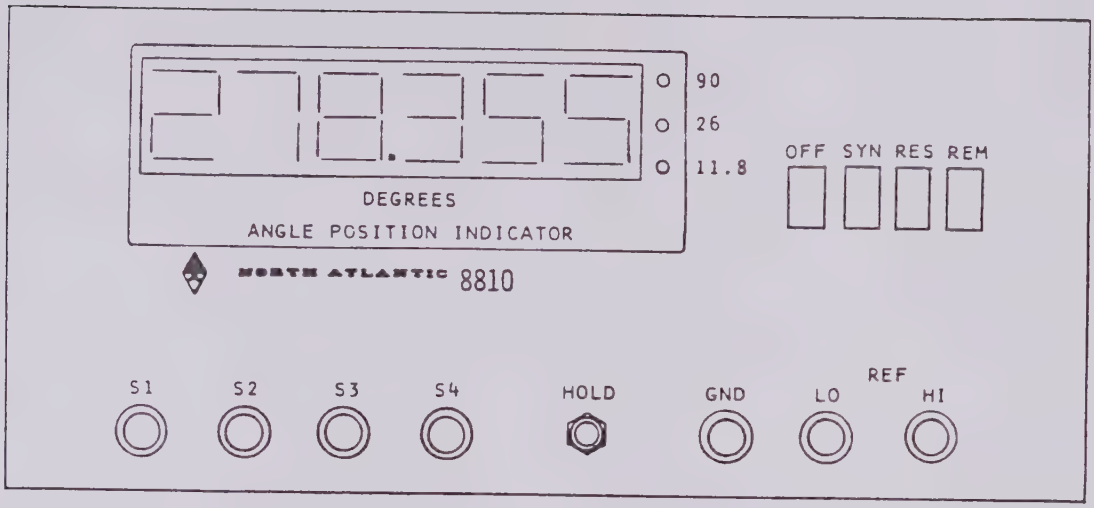


Figure 3-3. Controls and Indicators

3.4 DATA TRANSFER CONSIDERATIONS

3.4.1 Timing

The S/D converter output changes in discrete 1 LSB steps. To prevent data from changing during the time it is transferred into the system or computer, provisions have been made to insure data stability during this transfer.

3.4.2 Converter Busy

The first method of transferring converter output data into the system is to monitor the Busy signal supplied by the S/D converter. This signal is a 1µs-wide logic 1 pulse and indicates output data changes.

It is necessary to transfer data 2 µS after the trailing edge of the converter Busy. The data will be stable for a minimum of 5.5 µS when the converter is tracking at its maximum rate of 200°/S.

3.4.3 Data Freeze

The second method of transfer is to freeze the data output with an externally supplied inhibit signal. The inhibit should be applied for a minimum of 2 µS before transferring the data into the system.

Since the inhibit signal stops the S/D converter output from tracking, it should be applied for as short a time as necessary, othersise large errors will accumulate under high angular rate conditions. When this occurs, time will have to be allowed for the converter to settle. In general, application of the inhibit for less than 30 µS will produce a maximum peak transient error of less than 1 LSB at an angular input rate of 0.25 rps (90°/S).

Application of the inhibit for less than 3 µS will produce a maximum peak transient error of less than 1 LSB at an angular input rate of 2.5 rps (900°/S).

NOTE

At slower angular input rates the converter can be frozen for much longer periods with no appreciable error buildup. In addition, the change allows for a reasonable capacitive load on the digital output lines (500 pF or less). Special precautions must be taken for capacitive charge and discharge for applications with excessive capacitive loads.

A remote data freeze signal (+5 V) may be applied to the DF (pin 42) terminal of J1.

SECTION 4

THEORY OF OPERATION

4.1 GENERAL

This section contains theory of operation for the API.

4.2 DETAILED DESCRIPTION

The API is designed with NAI's closed servo loop (refer to block diagram, fig. 4-1). This system continuously tracks the analog input data with a precision Scott-T transformer, resistive bridge, phase detector, integrator, and clock generator, driving a counter which updates the bridge to the synchro data angle input.

The heart of the system is a custom LSI TRIG LOGIC™ processor. This LSI contains analog switches, an UP/DN counter and trigonometric digital circuitry for processing the input signals.

The input signal, whether synchro (three wire) or resolver (four wire) goes directly into the precision transformer assembly, which outputs a Sin θ signal and a Cos θ signal to the coarse bridge. Both signals drive analog switches which are turned at 40° intervals. These points are referrred to as αc. The signals produced within the coarse bridge circuit are Sin θ Cos αc, Sin θ Sin α, Cos θ Cos αc, and Cos θ Sin αc. These four functions are combined to derive Sin (θ-αc) error signal and Cos (θ-αc) interpolation signal, implementing the following trigonometric relationships:

$$\text{Sin}(\theta-\alpha c) = \text{Sin}\,\theta\,\text{Cos}\,\alpha c - \text{Cos}\,\theta\,\text{Sin}\,\alpha c$$
$$\text{Cos}(\theta-\alpha c) = \text{Sin}\,\theta\,\text{Sin}\,\alpha c + \text{Cos}\,\theta\,\text{Cos}\,\alpha c$$

Since αc takes on values at only 40° intervals, θ-αc will be somewhere between 0° and ±20°, depending upon the value of the input angle θ. The error signal Sin (θ-αc) is then balanced out in the interpolation circuit, using Cos (θ-αc) as an interpolation reference signal.

The interpolation circuit contains a precision resistor network to bridge the error signal against the interpolation reference signal. The precision resistor network as well as the analog switches of the coarse bridge are driven digitally by the counter. The range of the interpolation section is 20°. When interpolating angles larger than αc, the output of the interpolation ladder is added to αc. When interpolating angles less than αc, the interpolation bits are complemented, the CEF switch is closed and the interpolation ladder subtracts from αc. This allows the interpolation section to cover a total span of 40°.

Since the Sin function is not a linear one, interpolating a full 20° would result in rather large errors. Several methods are used to reduce the interpolation error. The first is to break up the 20° interpolation span into two 10° segments. From 0° to 9.999°, the PRG supplies Sin 10° to ladder for interpolation. From 10° to 19.999°, the Sin 10° is applied to a resistor at the summing amplifier, and the Sin 20° to Sin 10° is applied to the interpolation ladder. This reduces the interpolation error to about ±0.005°. This error is further reduced by three analog switches which perform slight amplitude changes in the ladder reference. The final mathematical error is less than ±0.001°. The result of the bridging process is an ac error signal at the output of U13 proportional to Sin (θ-αc) Cos αf Cos (θ-αc).

This equals Sin (θ-αc-αf), where αf is the digitally generated angle in the interpolation circuit.

The output of summing amplifier U13 is fed to amplifier U17 for further amplification.

Since the ac scale factor changes with coarse bridge angles, it is necessary to normalize this scale factor to maintain constant sensitivity throughout the entire 360° span. Resistor R94 is switched in and out to eliminate this change. (The change would be 40% without this normalization.) In addition, gain changes to U17 are performed for line-to-line voltage changes.

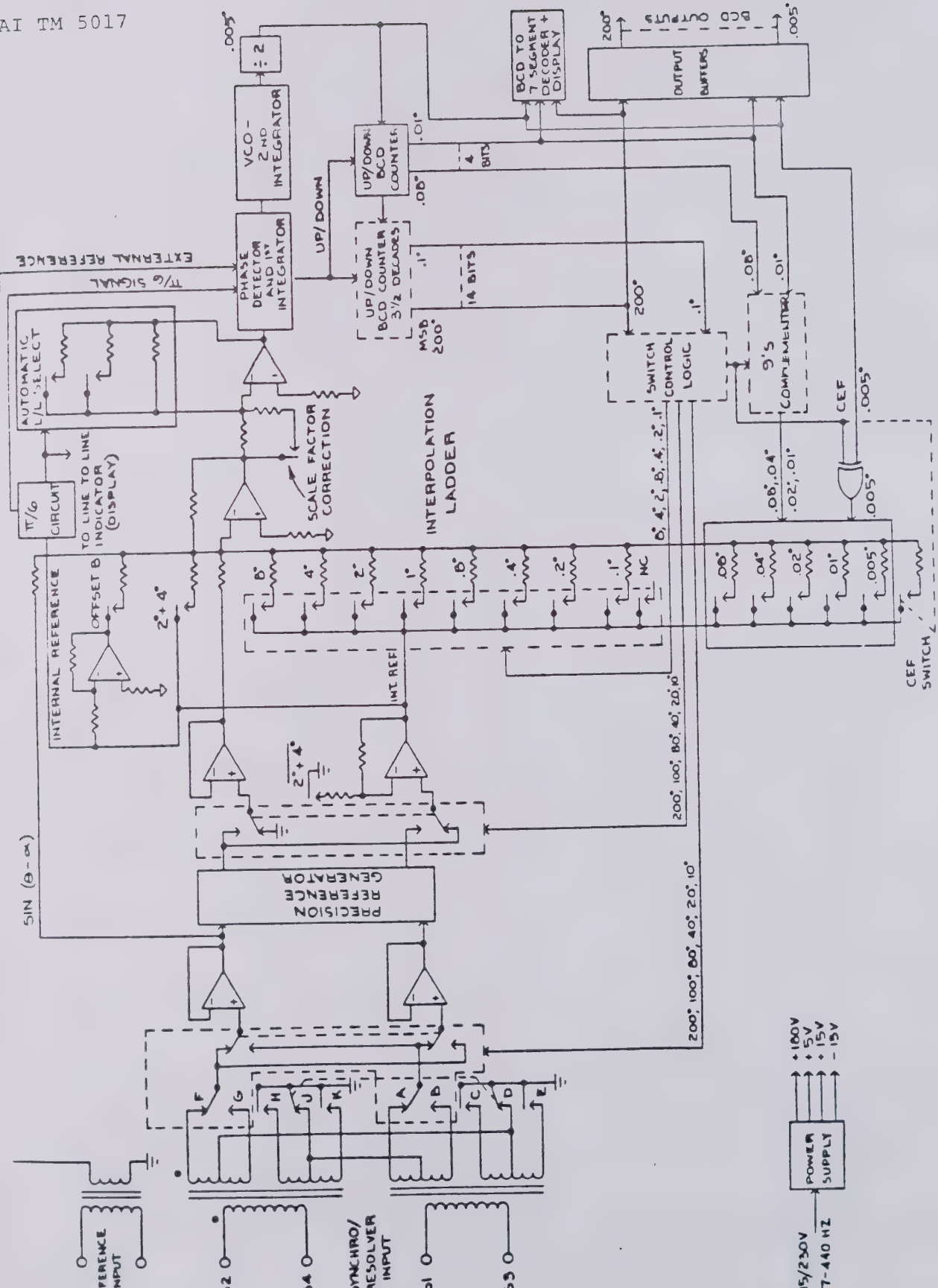


Figure 4-1. API, Block Diagram

11.8 V L-L, resistor R92 is the feedback. R91 is in parallel with R92 for 26 V L-L operation. For 90 V L-L operation, R90 and R91 are in parallel with R92. The scale factor at the output of U17 (TP7) is 2.5 V rms/degree at all three line-to-line levels.

In most S/D converters, reference to the null circuit is supplied externally from the same source exciting the synchro. Since all synchros generate phase shift, their output signal is phase shifted in respect to the reference, usually 5° to 30°. For optimum performance, the reference applied to an S/D converter should be phase shifted by the same angle as the synchro signal. The API contains an auto-phase circuit which eliminates the need for external reference phase correction. This circuit is able to correct for maximum phase shift of ±30°. Reference phase correction is accomplished by sampling the interpolation ladder reference. Since this signal is derived directly from the synchro input signal, it is inphase with the synchro signal.

The interpolation reference is coupled through C10 and applied to full wave rectifier circuit U14. FET switch Q8 switches the gain of the rectifier when the interpolation reference changes amplitude so that the rectified signal at TP9 is a constant amplitude (fig. 4-2). The output of the rectifier drives the inverting input (pin 6) of comparator U15. The output of the rectifier is divided and filtered by components R73, R74, and C12. This network applies exactly 50% of the peak value of the full-wave rectified signal which corresponds to the Sin of 30°. This develops a π/6 (±30°) signal at the output of the comparator (TP10). The π/6 signal is applied to the phase detector which is discussed later.

For scale factor correction is made with , the output voltage of the rectifier is directly proportional to the input line-to-line voltage. The filtered voltage at C12 is buffered by voltage follower U14, and the output (TP11) is connected to two comparators. The dc voltage (TP11) is approximately 1/20th of input line-to-line voltage (rms). The two comparators sense the voltage amplitude at TP11. When the voltage is less than 0.9 V, the outputs of both comparators are low. This sets the gain of U16 for 11.8 V L-L. When the voltage is between 0.9 V and 1.8 V, the output of U15, pin 13, goes high, and switches the API to 26 V L-L. When the voltage at TP11 exceeds 1.8 V, both comparator outputs go high, switching the API to 90 V L-L. the outputs of the comparators are decoded by U16 to drive the line-to-line indicator LEDs on the front panel.

The null circuit receives the π/6 signal, the external reference, and the ac error signal from U17. This circuit performs three discrete functions: (1) phase-sensitive detection, (2) clock pulse generation, and (3) count up/count down signal. In addition, an Auto-phase defeat switch is provided so that, if necessary, the synchro information may be referenced to the external reference. With the Auto-phase switch in the external position, the phase detector operates as a normal full wave detector. This mode of operation is explained first.

The external reference applied to J1 is isolated and stepped down by transformer T3. This signal is squared by comparator U15. At this point the signal splits. One side is connected to U21, pin 6, the other inverted by U20. This inverted signal connects to U21, pin 8. Since the π/6 signal is grounded by S6, the NAND gates function as inverters. This two-phase reference signal is buffered and drives the phase detector switches. The third grounding switch remains open.

The ac error signal from U17 is coupled through C15 to U18. With the Auto-phase switch in the external position, U18 operates as a non-inverting unity gain buffer. The signal at TP8 is identical to that at TP7, except that any dc offset present at TP7 is blocked by C15. This signal is applied to one of the phase detector switches. The ac error signal at TP8 is also inverted by U19 and fed to another phase detector switch. These two switches alternately open and close inphase with the external reference and form a phase-sensitive full wave detector. The output of the phase

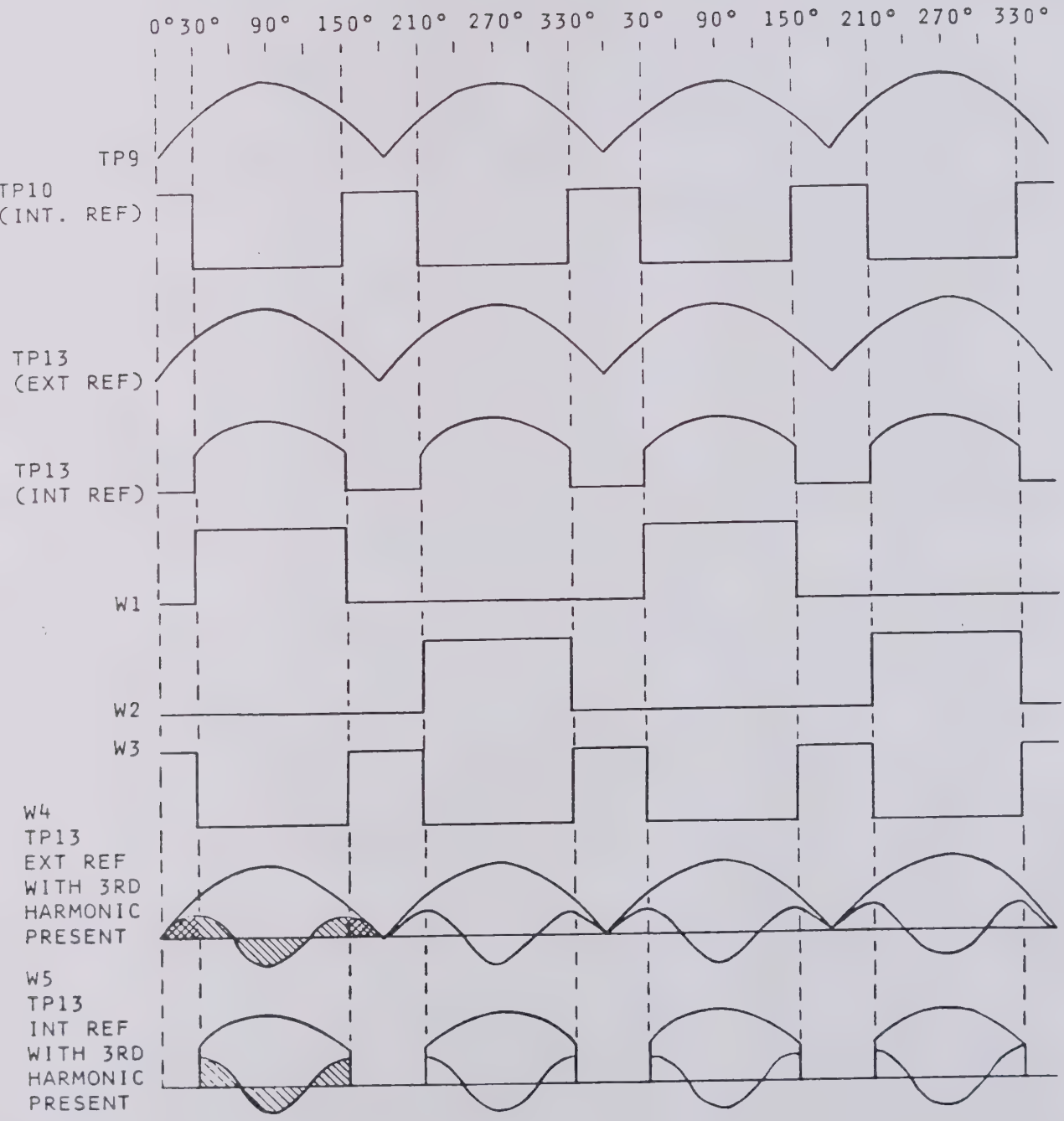


Figure 4-2. Null Circuit Waveforms

etector is a dc signal whose amplitude is proportional to the inphase portion of the c error signal. Polarity depends on hether the ac error signal is inphase or 180° out-of-phase with the reference. U23 integrates the phase detector output.

When the Auto-phase switch is in the INT position, the π/6 signal is digitally combined with the external reference square wave. The π/6 signal removes 30° of the leading and trailing edges which reduces the switch closure angle from 180° to 120° (waveforms W1 and W2, fig. 4-2). Grounding switch U22, pin 2 is closed when the other switches are both open to insure no signals leak through to the integrator during the π/6 interval (waveform W3, fig. 4-2). Since this reduces the gain of the phase detector, resistor R97 is grounded by the Auto-phase switch, increasing the gain of U18 proportionately.

In addition to automatic phase correction, the π/6 null circuit provides complete rejection of the third harmonic and all multiples of the third harmonic. A normal full wave detector provides a 3:1 attenuation of 3rd harmonics and an attenuation of all other odd harmonics proportional to the ratio of the harmonic to the fundamental (i.e., 7th harmonic 7:1, etc.). For all odd harmonics, not a multiple of the third harmonic, the π/6 phase detector provides the same attenuation as the full wave phase detector. Both types provide complete rejection of even harmonics.

A circuit in the null circuit, not mentioned, consists of a half-wave rectifier and filter, comprising of CR20, R104, R107, and C16. Comparator U14 monitors the voltage across C16 and trips when the ac error is greater than 10 V rms. This occurs when the angular error between the API and synchro exceeds 4°. This will cause the internal signal supplied to the π/6 circuitry randomly to change amplitude until the converter slews closer to the input angle. This results in a momentary disruption of the π/6 signal applied to the phase detector. To insure proper operation of the phase detector, the π/6 signal is disabled by comparator U14, pin 10 until the error is reduced.

The API uses a Type II servo, which does not require a continuous error signal to generate clock pulses. Depending upon the phase relationship with the reference and the direction of the synchro rotation, an ac error signal will either accelerate or decelerate the clock until clock rate matches the rate of the incoming synchro data. At this point, the ac error signal drops to zero and the clock continues to run at its present rate until an ac error signal again appears to accelerate or decelerate it.

The VCO consists of integrator U24 and two sections of comparator U25. In operation, a dc voltage from U23 charges C23 through R117 and R118 until the output of U24 reaches the trip point of one of the comparators. When this occurs, CR25 or CR26 is forward biased and C23 discharged until the comparator flips back to its original state. The cycle is then repeated. The up clock pulses are derived from U25, pin 1 and the down clock pulses are derived from U25, pin 2. The output of U24 is also fed to comparator U25, pin 10 to develop an up/down signal for the LSI counter.

The clock lines drive the BCD up/down counter. The counter outputs (decoded and complemented) close the loop with the coarse bridge and interpolation circuits. The digital word, in BCD form, from the LSI goes to the output buffers. These buffers isolate the LSI and drive the rear connector for external use. They also go to the display board for decoding to drive the seven segments of the Beckman Planar Gas Discharge Information Display.

4.3 IEEE INTERFACE BLOCK DIAGRAM DESCRIPTION

Refer to figure 4-3 for the following discussion. The diagram represents the interface system required to connect the API to the IEEE Standard Digital Interface for Programmable Instrumentation (IEEE Std-488-1975).

The interface accepts control signals and control data from the IEEE bus, and outputs control signals, angle position data and status data to the IEEE bus. All data transfers on the bus use the ASCII. The

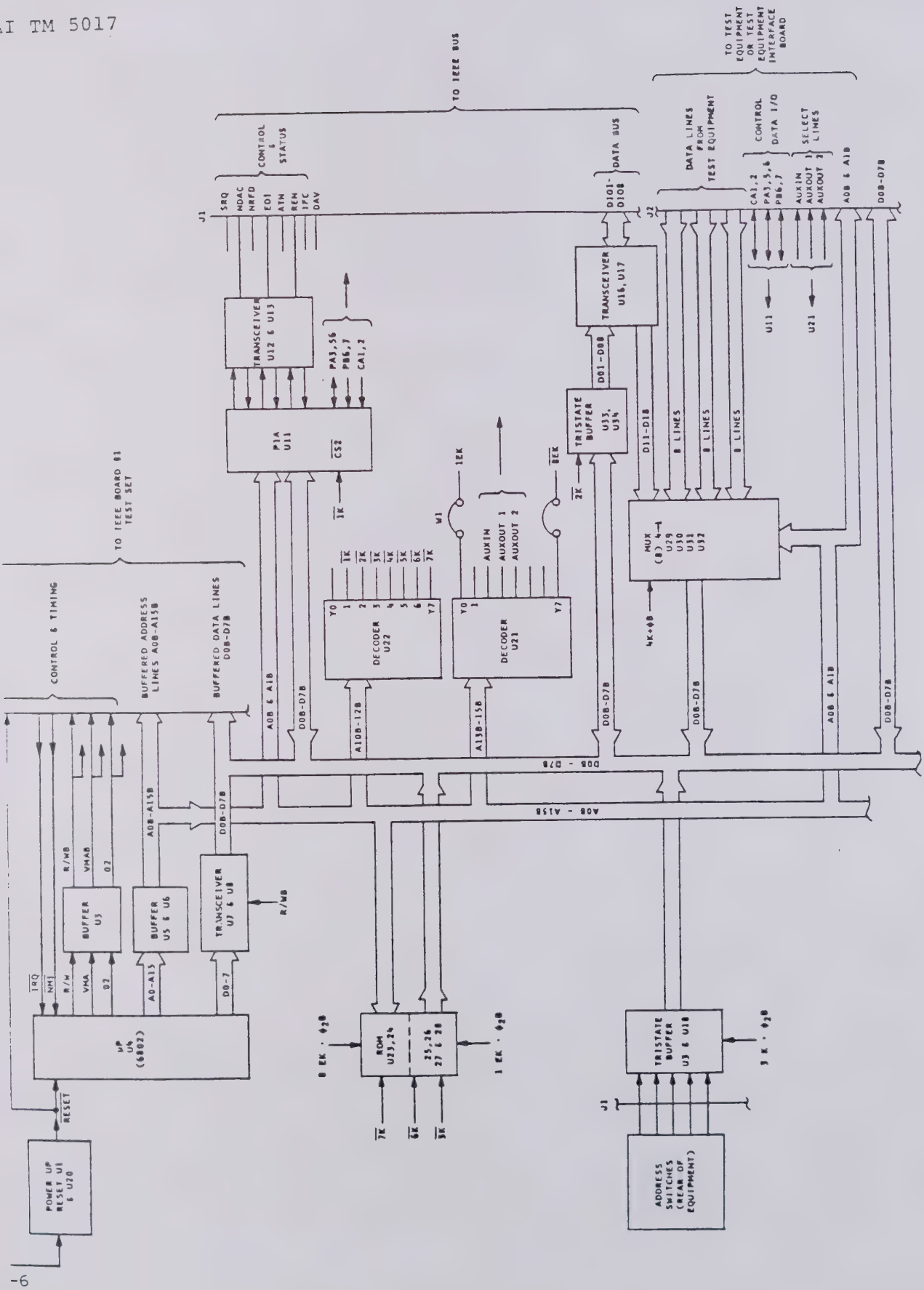


Figure 4-3. IEEE Interface Board, Block Diagram

IEEE bus is connected to J6 on the back of the API and interconnected to J1 on the interface.

The interface responds to the bus by providing control siganls to the API, and accepting BCD and status data words from the API. These functions are connected from J2 of the IEEE board to J6 on the back of the API.

The interface accepts control signals and data while in the listen mode. It transmits data in the talk mode. Control of the interface is performed by a 6800 microprocessor and the program stored in the ROM. Under control of the program the µP (U4) checks control lines, sets registors, converts BCD to ASCII, and transmits the data and status words.

The interface consists of a power-up reset, a µP, address and data line buffers, ROMs decoders, PIA, transceivers, tristate buffers, and multiplexers. The function of each group is explained below.

4.3.1 Power-Up Reset

The power-up reset circuit resets the µP every time power is turned on. While in this state, address line A0 of the µP is set to 0 and address lines A1 through A15 are set to 1. This is the address of the MSB of the power-up routine located in the ROM. When the power reset state ends, the µP places the next address on the address bus. Address lines A0 through A15 to go 1. This is the LSB of the address of the power-up routine. The µP than places the address of the power-up routine on the address bus and commences to initialize the registers within the interface.

The PIA (U11) transfers control and status data between the IEEE bus control lines and the data bus of the µP. These lines are EOI, DAV, NRFD, NDAC, IFC, SRQ, ATN, and REN (refer to table 2-3). It transfers these signals by way of transceivers U12 and U13. The transceiver receives or transmits on command from the µP.

Before the PIA (or any of the other devices connected to the data bus) can accept or place data on the bus it must be selected (enabled) by decoder U22. The decoder enables, one-at-a-time, the different bus-connected devices according to the state of address lines A10B through A12B connected to its input. Devices are selected as shown in table 4-1.

Table 4-1. U22 Address Lines

Address code			Decoder (U22) output	Device connected to bus
A12B	A11B	A10B		
0	0	0	NC	
0	0	1	1K	PIA U11
0	1	0	2K	Tristate buf U33,U34
0	1	1	3K	Tristate buf U3, U18
1	0	0	4K	MUX U29,U30,U31,U32
1	0	1	5K	Not used with API
1	1	0	6K	Not used with API
1	1	1	7K	Hi PROM, U23, U24

A second decoder (U21) is used for overall selection. It is controlled by address lines A13B through A15B as shown in table 4-2.

Table 4-2. U21 Address Lines

Address code			Decoder (U21) output	Groups enabled
A15B	A14B	A13B		
0	0	0	$\overline{\text{IEK}}$	All above devices
0	0	1	AUXIN	
0	1	0	AUXOUT 1	
0	1	1	AUXOUT 2	
1	0	0		Not used with API
1	0	1		Not used with API
1	1	0		Not used with API
1	1	1	$\overline{\text{8 EK}}$	Hi PROM, U23, U24

U21 acts to enable all devices when A13B through A15B are all zero. U21 acts to enable the high PROM when A13B through A15B are all ones. This fact is used with power-up reset. When power-up reset is enabled, A10B through A15B are all ones. From the two preceeding tables, all ones enables (U22) 7K and 8EK. $\overline{\text{7K}}$ and $\overline{\text{8EK}}$ enable the high ROM U23 and U24. In addition, AØB=0 and A1B through A9B=1 during reset. This condition addresses the next to least byte in the high ROM. The next to last and last

tes contain the address of the power-up utine in the ROM and are needed as dis- ssed before to initialize the interface.

e address of the interface is selected a five-bit DIP switch available on the ck panel. The switch setting is trans- rred to the data bus by tristate buffers and U18. These buffers are enabled by when the current address setting is re- ired by the ROM program.

istate buffers U33 and U34 allow data on e µP bus to be connected by way of trans- ivers U16 and U17 to the data lines of e IEEE bus. U33 and U34 are enabled by . This is the talker or source mode.

nversely data can pass from the data lines the IEEE bus through the transceivers to ltiplexers U29, U30, U31, and U32. When e multiplexers are enabled by 4K, A0B and B equal 0, data from the IEEE bus is connected to the µP bus. When the A0B and A1B are 01, 10, or 11, data is transferred from the API to the µP data bus. 24 lines transfer the six BCD outputs of the API. The multiplexer samples these eight bits at a time.

Several control outputs are required by the API. One selects the synchro or resolver modes. The other allows the API to track its input signal or freeze the current API reading. In addition, the API produces a Busy which is used by the interface. These signals communicate between the µP bus and the API by way of the PIA (U11). These are the special lines at J2 labeled PA3, PA5, PA6, PB6, PB7, CA1, and CA2.

Utilizing the hardware described above, the program in ROMs U23 and U24 can perform any IEEE function required to control the API, transfer data from the API to the IEEE bus, and respond with a status word on request.

SECTION 5

MAINTENANCE

5.1 GENERAL

This section contains cleaning, performance tests, and alignment procedures for the API.

WARNING

High voltages exist at several points in this instrument. Normal precautions should be taken to avoid shock hazard.

CAUTION

The API contains the following MOS integrated circuits. Handle these ICs with extreme care. Never remove an IC with the power on. Use only properly grounded test equipment.

U3 - LSI
U16,21,26,30 - 4011
U27 - 4027
U28 - 4030/14070
U29 - 4069
U31 - 74C192/34192
U32 - 14561
U33,34,35 - 74C902(8810 only)
*U201 - 74C192
*U202 - 74C902
*U203 - 14561
**Z1 - 74C00
**Z2,5,8,11,14 - MC14519
**Z3,6,9,12,15 - MC14560
**Z4,7,10,13,16 - MC14561

*0.001° resolution units only
**±180° digital board

5.2 CLEANING

No special cleaning procedures or fluids are required. Apply good housekeeping rules to maintain the instrument free of dust and dirt.

5.3 PERFORMANCE TEST

The API is designed to operate as a solid state, two-channel, synchro or resolver-to-digital converter with a built-in display. This display is a gas discharge type located on the front panel. The synchro or resolver input data frequency range is determined by the options selected (para. 1-4).

The following paragraphs provide performance test procedures. Perform these tests periodically to ensure proper equipment operation.

5.3.1 Equipment Required

Table 5-1 lists the test equipment required to test and align the API. The minimum use/critical specification column lists the parameters required for alignment and are not for the purpose of alternate equipment selection. Satisfactory performance of alternates should be verified before use.

Table 5-1. Test Equipment Required

Item	Minimum use/critical specifications	Manufacturer and model
Synchro/resolver simulator	Frequency: 400 Hz Range: 00.0000° to 359.9999° Accuracy: 2 arc seconds Modes: Synchro or resolver. Synchro conventions meet MIL-S-20708A. Resolver conventions meet MIL-R-21530 (para. 3.2).	North Atlantic Industries, Model 530-S741 Synchro Resolver Simulator

Table 5-1. Test Equipment Required (Continued)

Item	Minimum use/critical specifications	Manufacturer and model
ating connector	Connector wired for the functions to be tested.	North Atlantic Industries mating connector kit 783718 Qty — AMP P/N 1 shell — 205211-1 1 clamp — 205732-1 2 retainer — 205980-1 50 pins — 66569-3
c power source	Frequency: 400 Hz Range: 0 V to 120 V rms Distortion: 0.6% Output rating: 20 VA Load regulation: ±1% Phase: Single	Elgar, Model 121 with Model 401V plug-in
hase angle oltmeter	Frequency: 400 Hz Sensitivity: 300 V to 0.003 V Mode: In-phase Voltage accuracy: ±2% full scale Phase accuracy: ±1°	North Atlantic Industries, Model 213C or 225 Phase Angle Voltmeter
scilloscope	Horizontal sweep time: 1 µS Vertical sensitivity: 1 V/cm Rise time: 24 nS Input R and C: 1 MΩ paralleled by ±2% approx. 33 pf	Tektronix, Model 422
VM	Range: 199.9 mV Z in: 100 MΩ Accuracy: ± 0.05% Resolution: 3-1/2 digits	Weston, Model 4449

3.2 Set-up

- Wire up the test connector and connect the equipment as shown in figure 5-1.
- Set the synchro/resolver simulator MODE switch to OFF to avoid damage to the equipment and to prevent dangerous voltages from existing at the output terminals when Power switches are turned on.
- Turn all Power switches (with the exception of the API) on and allow the test equipment to stabilize.
- Set the synchro/resolver simulator for 11.8 V L-L, 400 Hz resolver output (00.000°).

e. Adjust the variable power and reference source for 400 Hz ±10 Hz, 115 V ±2 V output.

5.3.3 Resolver Accuracy Test

a. On API, depress RES push button. The 11.8 V LED lights.

b. Advance the synchro/resolver simulator in 10° steps (00.000° through 350.000°). API should read within ±0.004° of the input angle for standard and low frequency option units, and within ±0.01° for ±180° option units.

c. Advance the resolver/synchro simulator in 1° through 9°, 0.1° through 0.9°, and 0.01° through 0.09° steps, respec-

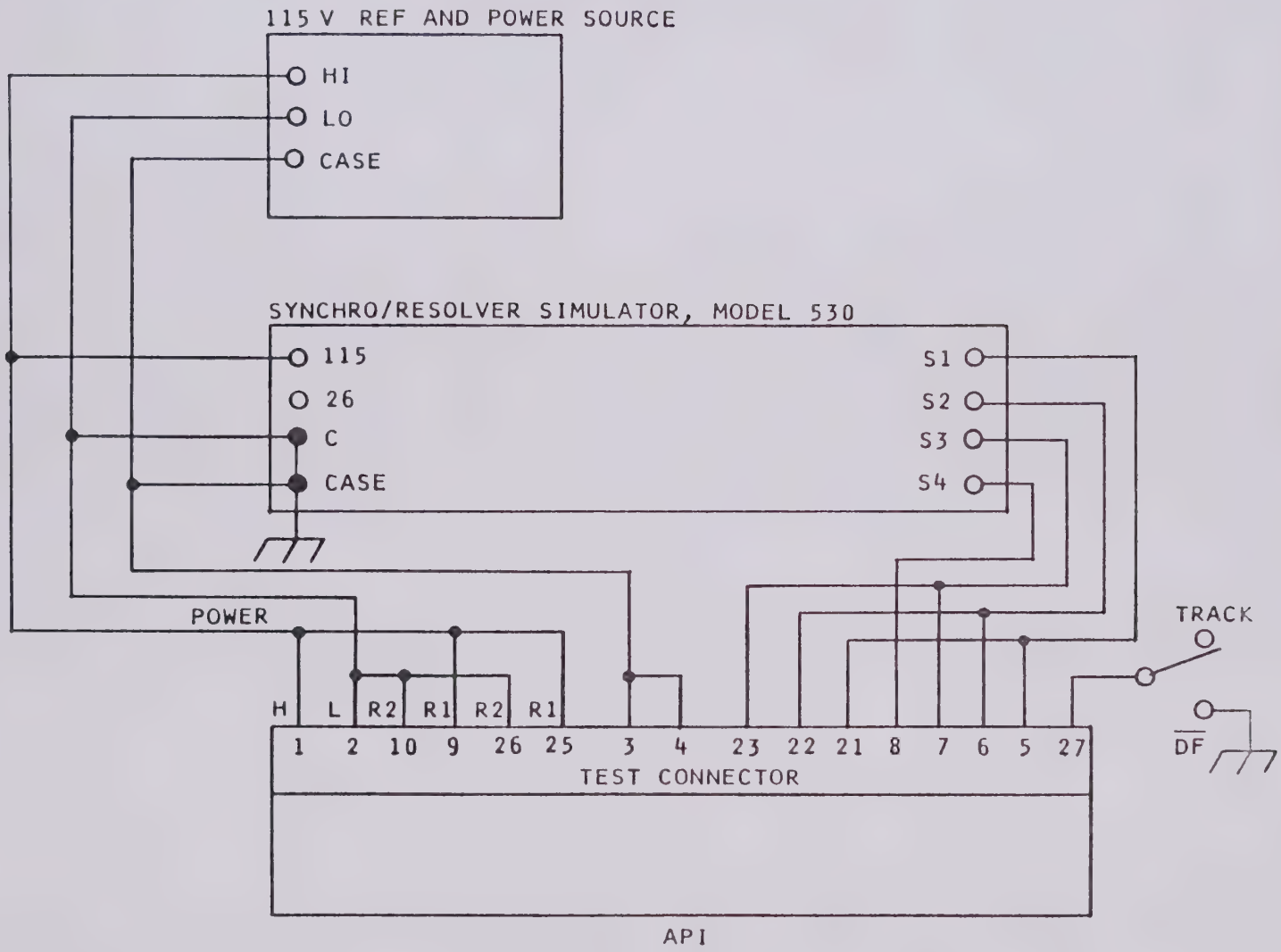


Figure 5-1. Test Set-up

tively. API should read within ±0.004° of the input angle for standard and low frequency option units, and within ±0.01° for ±180° option units.

3.4 Synchro Accuracy Test

Depress SYN push button on the API.

Set the synchro/resolver simulator for 26 V L-L output. The 26 V LED on the API lights.

Set the synchro/resolver simulator for 90 V L-L synchro output. The 90 V LED in the API lights.

Advance the synchro/resolver simulator in 10° steps (00.000° through 350.000°). API should read within ±0.004° of the input angle for standard and low frequency option units, and within ±0.01° for ±180° option units.
Advance the synchro/resolver simulator in 1° through 9°, 0.1° through 0.9°, and 0.01° through 0.09° steps, respectively. API should read within ±0.004° of the input angle for standard and low frequency option units, and within ±0.01° for ±180° option units.

4 ALIGNMENT PROCEDURE

is procedure describes the alignment se-
ence and test equipment required to align
e API. The unit is aligned by adjusting
ght potentiometers for proper dc offsets
various test points. Periodic alignment
unnecessary and should not be attempted
less the performance test reveals a mis-
igned condition.

4.1 Set-up

Set Mode switch on synchro/resolver simulator to OFF to avoid damage to the equipment and to prevent dangerous voltages from existing at the output terminals when power switches are turned on.

Turn all Power switches (with the exception of the API) on and allow time for the auxiliary equipment to stabilize.

c. Wire up the test connector and connect the equipment as shown in figure 5-1.

d. Set the synchro/resolver simulator for 11.8 V L-L, 400 Hz synchro output at 0.000°.

5.4.2 Procedure

a. Depress SYN push button on the API. Adjust the synchro/resolver simulator for 0.000° angle position indicator display and set the toggle switch to $\overline{DF}$. Adjust synchro/resolver simulator for 0.0000°.

b. Connect the low side of the DVM to TP1 (ground) on the mother board and connect the high side to TP4. The voltage at TP4 should be between +0.5 mV dc and +3 mV dc.

c. Connect the high side of the DVM to TP2. Adjust R19 until the voltage at TP2 is the same as that measured at TP4 ±100 µV

d. Connect the high side of the DVM to TP3. Adjust R26 until the voltage at TP3 is the same as that measured at TP4 ±100 µV

e. Connect the high side of the DVM to TP5 and adjust R29 for 0 mV ±100 µV. This is a preliminary adjustment

f. Connect the high side of the DVM to TP7 and adjust R55 for 0 V ±200 mV.

g. With the DMV at TP7, set the simulator to 10.000°. Manipulate the simulator so that the API display indicates 10.000°. Freeze the API. Set the simulator again to 10.000°. Note dc offset at TP7.

h. Remove data freeze. Manipulate the simulator so that the API display indicates 9.999° (9.995° for units with 0.005° resolution). Freeze the API and set the simulator to 9.999 (9.995° for units with 0.005° resolution). Read the dc offset at TP7. Readjust R29 unti the offset is the same as that obtained in step g above. Repeat steps g and h to assure no change in dc offset.

i. Connect the low side of the scope to TP1 (GND) and the high side to TP10 (use an X10 probe).

j. Set the vertical sensitivity to 2V/division (pulse to be measured in 5 V pp) and the time base to 0.1ms/division. Adjust the scope time base and triggering so that the scope triggers on each successive pulse.

k. Adjust R65 so that pulses are of equal width (double edges on scope overlap and appear as a single edge).

l. Connect the DVM to TP12 and adjust R103 for 0 mV±500μV. This is a preliminary adjustment. Final adjustment will be made later.

m. Connect the PAV to TP7. Adjust the simulator for an in-phase null at TP7 (angle on synchro/resolver simulator should be 0.000° ±.002°).

n. Connect the DVM to TP14 and adjust R116 for 0 V±200mV.

o. Switch the Auto-phase switch on the main board from INT to EXT and note offset change at TP14. If there is, readjust R103 until there is no dc change at TP14 when the unit is switched from INT to EXT.

p. Readjust R116 for 0 V±200mV at TP14.

q. Connect the PAV to TP7. With data freeze removed, set the simulator to 20.000°. Freeze the API. Adjust the simulator for an in-phase null at TP7. Record the simulator setting (20.000° ±0.002°).

r. Remove data freeze. Manipulate the simulator so that the API display indicates 19.999° (19.9995° for units with 0.005° resolution). Freeze the API. Adjust the simulator for an in-phase null. Record the simulator setting.

s. Subtract the simulator setting of step r, above, from that of step q. The difference should be 0.001° (0.005° for units with 0.005° resolution). Adjust R63, if necessary, to obtain this difference.

t. Repeat steps q through s until desired result is obtained.

u. Advance the simulator through 360° in 10° steps, observing the API display. Ascertain that the largest angle errors are distributed as positive and negative errors. If maximum angle errors tend to be of the same sign (all positive or all negative), readjust R116 to minimize these errors.

SECTION 6

PARTS LIST

This section provides a vendor codes list, parts list, and parts locator diagrams for the API.

List of Manufacturers

Code	Manufacturer's Name and Address
00779	AMP Inc., Harrisburg, Pennsylvania 17105
01121	Allen-Bradley Company, Milwaukee, Wisconsin 53204
01295	Texas Instruments, Dallas, Texas 75265
02111	Spectrol Electronics, City of Industry, California 91745
03508	General Electric Company, Auburn, New York 13021
04713	Motorola Semiconductor, Phoenix, Arizona 85008
06751	Components, Inc., Semcor Division, Phoenix, Arizona
06776	Robinson Nugent, New Albany, Indiana 47150
07187	Sperry Corporation, Albuquerque, New Mexico 87119
07263	Fairchild Camera, Mountain View, California 94042
07342	North Atlantic Industries, Inc., Hauppauge, New York 11788
07980	Hewlett-Packard Co., Rockaway, New Jersey 07866
08779	Signal Transformer, Inwood, New York 11696
09353	C & K Components, Newton, Massachusetts 02158
09922	Burndy Corporation, Norwalk, Connecticut 06856
12040	National Semiconductor, Danbury, Connecticut 06810
12749	James Electronics, Inc., Chicago, Illinois 60618
16299	Corning Glass Works, Raleigh, North Carolina 27604
18677	Scanbe Manufacturing Company, El Monte, California 91731
22526	EI DuPont, Berg Electronics Div., New Cumberland, Pennsylvania 17070
28218	3M Company, 3M Center, St. Paul, Minnesota 55144
28480	Hewlett-Packard Co., Palo Alto, California 94304
30870	Republic Machinery Co., Carson, California 90749
32997	Bourns Inc., Riverside, California 92507
55261	LSI Computer Systems Inc., Melville, New York 11747
56289	Sprague Electric Company, North Adams, Massachusetts 01247
71590	Centralab Inc., Fort Dodge, Iowa 50501
72136	Electro Motive Corporation, Florence, South Carolina 29501
72982	Murata Erie North America, Erie, Pennsylvania 16512
73138	Beckman Industries, Fullerton, California 92634
74840	Illinois Capacitor, Inc., Lincolnwood, Illinois 60645
75037	3M Electro Products Division, St. Paul, Minnesota 55101
75915	Tracor Littelfuse, Inc., Des Plaines, Illinois 60016
79727	C-W Industries, Southampton, Pennsylvania 18966
91637	Dale Electronics Corporation, Columbus, Nebraska 68601
97525	EECO, Santa Ana, California 92701

Replacement Parts List - Model 8810

Ref. Des.	Description	NAI Part No.	Mfr. Code	Mfr. Part No.	Total Qty
	Chassis Assembly	783733			
	Chassis Assembly	783784			
	360° Display Board	783739			
S1	Switch, Pushbutton	808178	09353	8531MNZB	1
	Switch, Slide	808112	79727	GF126	1
	Plug, Dip (16-pin)	807221	75037	3416-0000	1
	I.C. Socket (16-pin)	807474	01295	3416-0000	1
					1
		OPTIONS			
	±180° Display Board	783747			
	±180° Digital Board	783719			
	IEEE Interface	783777-02			

Replacement Parts List: Chassis Assembly (783733, 783784)

Ref. Des.	Description	NAI Part No.	Mfr. Code	Mfr. Part No.	Total Qty
C1	Capacitor, Mica 15pf, 200V, ±10%	807269		CK05BX150K	9
C2	Same as C1				
C3	Same as C1				
C4	Same as C1				
C5	Same as C1				
C6	Same as C1				
C7	Capacitor, Ceramic .1µf, 100V, ±10V	805154		CK06BX104K	24
C8	Same as C7				
C9	Same as C7				
C10	Capacitor, Tantalum 10µf, 15V, ±10%	805643	06751	TS2K-15-106K	2
C11	Same as C1				
C12	Same as C10				
C13	Same as C7				
C14	Same as C7				
C15	Capacitor, Ceramic 1µf, 50V, ±10%	805155		CK06BX105K	2
C16	Same as C15				
C17	Same as C7				
C18	Same as C7				
C18[4]	Capacitor, Ceramic .39µf, 50V, ±10%	808193	56289	5CX7R394X9100C5	2
C19	Capacitor, Ceramic .33µf, 50V, ±10%	882457		CKR06BX334XP	1
C19[4]	Same as C18[4]				
C20[6]	Capacitor, Ceramic .068µf, 100V, ±10%	805468		CK06BX683K	1
C20[4]	Capacitor, Ceramic .082µf, 100V, ±10%	808405		CK06BX823K	1
C21	Same as C7				
C22	Capacitor, Ceramic .056µf, 100V, ±10%	805454		CK06BX563K	1
C22[4]	Capacitor, Ceramic .82µf, 50V, ±10%	805076		CK06BX824X	1
C23	Capacitor, Ceramic 100pf, 200V, ±10%	805210		CK05BX101K	1
C23[4]	Capacitor, Ceramic 390pf, 200V, ±10%	805284		CK05BX391K	1

[4] Low frequency option
[6] Standard and ±180° option

Replacement Parts List: Chassis Assembly (783733, 783784) (Continued)

Ref. Des.	Description	NAI Part No.	Mfr. Code	Mfr. Part No.	Total Qty
C24	Same as C7				
C25	Capacitor, Ceramic 27pf, 200V, ±10%	808401		CK05BX270K	2
C26	Same as C25				
C27	Same as C7				
C28	Capacitor, Ceramic 100pf, 200V, ±10%	805210		CK05BX101K	2
C29	Same as C28				
C30	Same as C7				
C31	Same as C1				
C32	Same as C7				
C33	Same as C7				
C34	Same as C7				
C35	Capacitor, Aluminum 470µf, 35V, ±10%	807685	56289	503D477G035ER	2
C36	Capacitor, Tantalum .22µf, 35V, ±20%	801297	56289	150D224X0035	2
C37	Same as C7				
C38	Same as C35				
C39	Capacitor, Tantalum 2.2µf, 35V, ±10%	802914	56289	150D225X8035B2	1
C40	Capacitor, Tantalum 1µf, 35V, ±20%	801343	56289	150D105X0035A2	1
C41	Capacitor, Aluminum 1000µf, 16V, ±10%	807686	56289	503D108G016ER	1
C42	Same as C36				
C43	Same as C7				
C44	Capacitor, Aluminum 10µf, 250V, -10+75%	885188	74840	106RAR-250APX	1
C45	Same as C1				
C46	Same as C7				
C47	Same as C7				
C48	Same as C7				
C49	Same as C7				
C50	Same as C7				
C51	Same as C7				
C52	Capacitor, Ceramic 220pf, 200V, ±10%	805156		CK05BX221K	1
C53	Capacitor, Ceramic 4700pf, 200V, ±10%	805153		CK06BX472K	2
C54	Same as C53				

Replacement Parts List: Chassis Assembly (783733, 783784) (Continued)

Ref. Des.	Description	NAI Part No.	Mfr. Code	Mfr. Part No.	Total Qty
C55[2]	Same as C7				
C56[2]	Capacitor, Mica 2pf, ±1pf	806241	72136	DM5-020	1
C201	Same as C7				
C201[4]	Same as C7				
CR1	Diode, Signal 1N	808974	07263	1N4148	28
CR2	Same as CR1				
CR3	Same as CR1				
CR4	Same as CR1				
CR5	Same as CR1				
CR6	Same as CR1				
CR7	Same as CR1				
CR8	Same as CR1				
CR9	Same as CR1				
CR10	Same as CR1				
CR11	Same as CR1				
CR12	Same as CR1				
CR13	Same as CR1				
CR14	Same as CR1				
CR15	Same as CR1				
CR16	Same as CR1				
CR17	Same as CR1				
CR18	Same as CR1				
CR19	Same as CR1				
CR20	Same as CR1				
CR21	Same as CR1				
CR22	Diode, Signal	883449		1N6263	1
CR23	Transistor	807607	04713	2N4123	5
CR24	Same as CR23				
CR25	Same as CR1				
CR26	Same as CR1				
CR27	Same as CR1				
CR28	Same as CR1				
CR29	Same as CR1				
CR30	Same as CR1				
CR31	Same as CR1				
CR32	Diode	804477	04713	1N4001	3
CR33	Same as CR32				
CR34	Same as CR32				
CR35	Diode, 190V, 500mW, ±5%	808157	04713	1N5280B	1
F1	Fuse, .5A 3AG (115V units)	802900	75915	312.500	1
	Fuse, .25A 3AG (230V units)	802530	75915	312.250	1
	Fuseholder (3AG)(for F1)	800137	75915	342004	1

[2]783784 units only
[4]Low frequency option

Replacment Parts List: Chassis Assembly (783733, 783784) (Continued)

Ref. Des.	Description	NAI Part No.	Mfr. Code	Mfr. Part No.	Total Qty
J1	Connector, 50-pin	808198	00779	206971-1	1
J2	Socket, 25-pin	808363	06776	SB-25-T	4
J3	Same as J2				
K1	Relay	808015	00779	53451-1	2
K2	Same as K1				
Q1	Transistor	804583	01295	T1S73	7
Q2	Same as Q1				
Q3	Same as Q1				
Q4	Same as Q1				
Q5	Same as Q1				
Q6	Same as Q1				
Q7	Same as CR23				
Q8	Same as Q1				
Q9	Same as Q23				
Q10	Same as Q23				
Q11	Transistor	807690	04713	MPSA43	1
R1	Resistor, Composition 47kΩ, 1/4W, ±5%	801638	01121	CB4735	8
R2	Same as R1				
R3	Resistor, Composition 24kΩ, 1/4W, ±5%	801393	01121	CB2435	8
R4	Same as R3				
R5	Same as R1				
R6	Same as R1				
R7	Same as R1				
R8	Same as R1				
R9	Resistor, Composition 510kΩ, 1/4W, ±5%	802086	01121	CB5145	7
R10	Same as R9				
R11	Same as R9				
R12	Same as R9				
R13	Same as R9				
R14	Same as R9				
R15	Resistor, Matched Set	807726-3	07342		1
R15[5]	Resistor, Matched Set	808160-3	07342		1
R16	Resistor, Matched Set	807726-1	07342		
R16[5]	Resistor, Matched Set	808160-1	07342		
R17	Resistor, Matched Set	807726-2	07342		
R17[5]	Resistor, Matched Set	808160-2	07342		

[5] High temperature option

Replacement Parts List: Chassis Assembly (783733, 783784) (Continued)

Ref. Des.	Description	NAI Part No.	Mfr. Code	Mfr. Part No.	Total Qty
R18	Resistor, Composition 2MΩ, 1/4W, ±5%	807094	01121	CB2005	2
R19	Potentiometer, 100kΩ	807625	02111	62-1-1-104	4
R20	Resistor, Composition 1.6kΩ, 1/4W, ±5%	804078	01121	CB1625	3
R21	Resistor, Matched Set	807727-3	07342		1
R21[5]	Resistor, Matched Set	808161-3	07342		1
R22	Resistor, Matched Set	807727-1	07342		
R22[5]	Resistor, Matched Set	808161-1	07342		
R23	Resistor, Matched Set	807727-2	07342		
R23[5]	Resistor, Matched Set	808161-2	07342		
R24	Same as R18				
R25	Same as R20				
R26	Same as R19				
R27	Resistor, Metal Film 158kΩ, 1/10W, ±1/2%	808359	01121	CC1583D	1
R28	Resistor, Metal Film 750Ω, 1/10W, ±1/2%	808360	01121	CC7500RD	1
R29[1]	Potentiometer, 20kΩ (round)	808110	73138	62P-R-20K	2
R29[2]	Potentiometer, 20kΩ (square)	808229	02111	RT-24C2X	2
R30	Resistor, Metal Film 20kΩ, 1/10W, ±.5%	808226	16299	NC5 20K, 1/10W, .5%	2
R31	Resistor, Composition 10kΩ, 1/4W, ±5%	801006	01121	CB1035	14
R32	Same as R30				
R33	Resistor, Metal Film 2.10MΩ, 1/10W, ±1%	808107	01121	CC2104	1
R34	Resistor, Metal Film 698kΩ, 1/10W, ±.5%	808108	16299	NC5 698K, 1/10W, .5%	1
R35	Resistor, Matched Set	807728-3	07342		1
R35[5]	Resistor, Matched Set	808162-3	07342		1
R36	Resistor, Matched Set	807728-4	07342		
R36[5]	Resistor, Matched Set	808162-4	07342		
R37	Resistor, Matched Set	807728-5	07342		
R37[5]	Resistor, Matched Set	808162-5	07342		
R38	Resistor, Matched Set	807728-6	07342		
R38[5]	Resistor, Matched Set	808162-6	07342		
R39	Resistor, Matched Set	807728-7	07342		
R39[5]	Resistor, Matched Set	808162-7	07342		
R40	Resistor, Matched Set	807726-8	07342		
R40[5]	Resistor, Matched Set	808162-8	07342		

[1] 783733 units only
[2] 783784 units only
[5] High temperature option

Replacement Parts List: Chassis Assembly (783733, 783784) (Continued)

ef. es.	Description	NAI Part No.	Mfr. Code	Mfr. Part No.	Total Qty
:41	Resistor, Matched Set	807728-9	07342		
:41[5]	Resistor, Matched Set	808162-9	07342		
:42	Resistor, Matched Set	807727-10	07342		
:42[5]	Resistor, Matched Set	808162-10	07342		
:43	Resistor, Metal Film 250kΩ, 1/10W, ±.5%	806106	16299	NC5 250K, 1/10W,.5%	1
:44	Resistor, Metal Film 499kΩ, 1/10W, ±1%	806929	16299	NC5 499K, 1/10W,1%	1
:45	Resistor, Metal Film 1MΩ, 1/10W, ±1%	807692	91637	DC-1/8	2
:46	Resistor, Metal Film 2MΩ, 1/10W, ±1%	807691	91637	DC-1/8	1
:47[3]	Resistor, Metal Film 4.02MΩ, 1/10W, ±1%	808095	01121	CC4024F	2
:48[3]	Same as R47				
:48[4]	Resistor, Composition 20MΩ, 1/4W, ±5%	804362	01121	CB2065	2
:49	Resistor, Metal Film 976kΩ, 1/10W, ±1%	808097	01121	CC9763F	1
:50	Resistor, Matched Set	807728-2	07342		
:50[5]	Resistor, Matched Set	808162-2			
:51	Resistor, Metal Film 1.05MΩ, 1/10W, ±1%	808144	01121	CC1054F	1
:52	Resistor, Metal Film 26.7kΩ, 1/10W, ±1%	807634	01121	CC2672F	2
:53	Same as R9				
:54	Resistor, Composition 430Ω, 1/4W, ±5%	801399	01121	CB4315	1
:55[1]	Same as R19				
:55[2]	Resistor, Variable, 100k	808690	32997	3279-1-104	1
:56	Resistor, Composition 270Ω, 1/4W, ±5%	802190	01121	CB2715	1
:57	Resistor, Composition 470Ω, 1/4W, ±5%	880567	01121	CB4715	1
:58	Resistor, Matched Set	807728-1			
:58[5]	Resistor, Matched Set	808162-1			

[1] 783733 units only
[2] 783784 units only
[3] ±180° option
[4] Low frequency option
[5] High temperature option

Replacement Parts List: Chassis Assembly (783733, 783784) (Continued)

Ref. Des.	Description	NAI Part No.	Mfr. Code	Mfr. Part No.	Total Qty
R59	Resistor, Metal Film 20kΩ, 1/10W, ±1%	807049		RN55D-2002F	7
R60	Same as R59				
R61	Same as R59				
R62	Resistor, Composition 13kΩ, 1/4W, ±5%	802186	01121	CB1335	4
R63	Potentiometer, 200kΩ	808362	01121	A2A204	1
R65[1]	Same as R19				
R65[2]	Potentiometer, 100kΩ	807062	32997	3299W-104	1
R66	Resistor, Composition 10MΩ, 1/4W, ±5%	803389	01121	CB1065	3
R67	Resistor, Metal Film 10kΩ, 1/10W, ±1%	806103	16299	NC4 10K, 1/10W, 1%	2
R68	Same as R59				
R69	Resistor, Composition 6.8kΩ, 1/4W, ±5%	802189	01121	CB6825	8
R70	Resistor, Metal Film 243kΩ, 1/10W, ±1%	808186	01121	CC2433F	2
R71	Same as R70				
R72	Resistor, Metal Film 402kΩ, 1/10W, ±1%	808187	01121	CC4023F	1
R73	Resistor, Metal Film 27.4kΩ, 1/10W, ±1%	808098	01121	CC2742F	1
R74	Resistor, Metal Film 100kΩ, 1/10W, ±1%	806992		RN55D1003F	3
R75	Same as R69				
R76	Same as R3				
R77	Resistor, Metal Film 49.9kΩ, 1/10W, ±1%	807635	01121	CC4992F	6
R78	Same as R31				
R79	Resistor, Metal Film 3.32kΩ, 1/10W, ±1%	807631	01121	CC3321F	6
R80	Same as R31				
R81	Same as R79				
R82	Same as R31				
R83	Same as R66				
R84	Same as R66				
R85	Same as R31				

[1] 783733 units only
[2] 783784 units only

Replacement Parts List: Chassis Assembly (783733, 783784) (Continued)

f. s.	Description	NAI Part No.	Mfr. Code	Mfr. Part No.	Total Qty
6	Resistor, Composition 100kΩ, 1/4W, ±5%	801986	01121	CB1045	8
7	Same as R3				
8	Same as R31				
9	Same as R1				
0	Same as R77				
1	Resistor, Metal Film 221kΩ, 1/10W, ±1%	808099	01121	CC2213F	1
2	Resistor, Metal Film 267kΩ, 1/10W, ±1%	807641	01121	CC2673F	1
3	Resistor, Metal Film 4.99kΩ, 1/10W, ±1%	808182	01121	CC4991F	1
4	Resistor, Metal Film 16.2kΩ, 1/10W, ±1%	806559	16299	NC4 16.2K, 1/10W, 1%	1
5	Same as R1				
6	Same as R69				
7	Resistor, Metal Film 634kΩ, 1/10W, ±1%	808146	01121	CC6343F	1
8	Same as R74				
9	Same as R86				
0	Same as R59				
1	Same as R59				
2	Same as R31				
3	Same as R29[1]				
4	Same as R67				
5	Same as R31				
6	Resistor, Metal Film 78.7kΩ, 1/10W, ±1%	807288		RN55D7872F	1
7	Same as R77				
8	Same as R45				
9	Same as R77				
10	Same as R69				
11	Same as R31				
12	Resistor, Metal Film 90.9kΩ, 1/10W, ±1%	808185	01121	CC9092F	1
13	Resistor, Metal Film 133kΩ, 1/10W, ±1%	807639	16299	C4 133K, 1/10W, 1%	1
13[3]	Resistor, Metal Film 59kΩ, 1/10W, ±1%	808184	01121	CC5902F	1

3733 units only

.80° option

Replacement Parts List: Chassis Assembly (783733, 783784) (Continued)

Ref. Des.	Description	NAI Part No.	Mfr. Code	Mfr. Part No.	Total Qty
R113*	Resistor, Metal Film 232kΩ, 1/8W, ±2%	806937	16299	C4, 232K, 2%	1
R114	Same as R86				
R115	Resistor, Metal Film 100Ω, 1/10W, ±1%	808143	01121	CC1000F	1
R116	Same as R29[2]				
R117	Same as R31				
R118	Same as R74				
R119	Resistor, Metal Film 100kΩ, 1/10W, ±1%	806992	16299	C4, 100K, 1/10W, 1%	1
R119[3]	Resistor, Metal Film 41.2kΩ, 1/10W, ±1%	807695	01121	CC4122F	1
R119*	Resistor, Metal Film 100kΩ, 1/10W, ±1%	806992		RN55D1003F	1
R120	Same as R86				
R121	Same as R3				
R122	Same as R69				
R123	Same as R3				
R124	Resistor, Composition 130kΩ, 1/4W, ±5%	801394	01121	CB1345	1
R125	Same as R3				
R126	Same as R52				
R127	Same as R59				
R128	Resistor, Metal Film 13.3kΩ, 1/10W, ±1%	807633	01121	CC1332F	2
R129	Same as R79				
R130	Same as R79				
R131	Same as R77				
R132	Same as R128				
R133	Same as R79				
R134	Same as R79				
R135	Same as R77				
R136	Same as R69				
R137	Same as R62				
R138	Same as R69				
R139	Same as R62				
R140	Same as R62				
R141	Same as R86				
R142	Same as R86				

[2] 783784 units only
[3] ±180° option
* Low frequency option

Replacement Parts List: Chassis Assembly (783733, 783784) (Continued)

Ref. Des.	Description	NAI Part No.	Mfr. Code	Mfr. Part No.	Total Qty
R143	Resistor, Composition 18kΩ, 1/4W, ±5%	802183	01121	CB1835	3
R144	Same as R143				
R145	Resistor, Composition 91kΩ, 1/4W, ±5%	803240	01121	CB9135	1
R146	Same as R3				
R147	Same as R143				
R148	Same as R31				
R149	Same as R31				
R150	Same as R31				
R151	Same as R86				
R152[2]	Same as R31				
R153[2]	Resistor, Composition 330Ω, 1/4W, ±5%	880080	01121	CB3315	1
R154[2]	Same as R69				
R155[2]	Same as R86				
R156[2]	Resistor, Composition 510kΩ, 1/8W, ±5%	807623		RC05GF514J	1
R201[4]	Same as R48[4]				
R202[7]	Resistor, Composition 10MΩ, 1/4W, ±5%	803389	01121	CB1065	1
R203[7]	Resistor, Metal Film 4.99MΩ, 1/10W, ±1%	808254	16299	C4, 4.99M, 1/10W, 1%	1
R204[7]	Resistor, Metal Film 2.49MΩ, 1/10W, ±1%	808255	16299	C4, 2.49M , 1/10W, 1%	1
S1[1]	Switch, Pushbutton	808703	07342	808703	1 set
S1[2]	Switch, Pushbutton, DPDT	808111	07342	808111	1 set
S2[1]	Same as S1				
S2[2]	Same as S1				
S3[1]	Same as S1				
S3[2]	Same as S1				
S4[1]	Same as S1				
S4[2]	Same as S1				
S5	Switch, Slide, DPDT	808112	79727	GF126	2
S6	Same as S5				
T1[6]	Transformer, Scott-T	808029	07232	808029	1
T1[4]	Transformer, Scott-T	807799	07342	807799	1

[1] 783733 units only
[2] 783784 units only
[4] Low frequency option
[6] ±180° option
[7] Standard and low frequency option

Replacement Parts List: Chassis Assembly (783733, 783784) (Continued)

Ref. Des.	Description	NAI Part No.	Mfr. Code	Mfr. Part No.	Total Qty
T2	Transformer, Power	807659	07342	807659	1
T3[1,3]	Transformer, Reference	807570	07342	807570	1
T3[2,3,4]	Transformer, Reference	808148	07342	808148	1
U1	Integrated Circuit	807626	12040	LM339N	4
U2	Same as U1				
U3	Integrated Circuit, LSI	807155	55261	2201N	1
U4	Integrated Circuit	807797	12040	LF356C	7
U5	Same as U4				
U6	Integrated Circuit	807530	07263	μA4136PC	4
U7	Same as U4				
U8	Integrated Circuit	808089	12040	LF13202(N)	4
U9	Same as U6				
U10	Same as U6				
U11	Same as U8				
U12	Same as U8				
U13	Integrated Circuit	808145	12040	LF357C	3
U14	Same as U6				
U15	Same as U1				
U16	Integrated Circuit	808092	04713	MC14011BF	4
U17	Same as U13				
U18	Same as U4				
U19	Same as U4				
U20	Integrated Circuit	808188	12040	DM74L04N	1
U21	Same as U16				
U22	Same as U8				
U23	Same as U4				
U24	Same as U4				
U25	Same as U1				
U26	Same as U16				
U27	Integrated Circuit	808093-MOS	04713	4027	1
U28	Integrated Circuit	808091	04713	MC14070BP	1
U29	Integrated Circuit	808090	04713	MC14069BP	1
U30	Same as U16				
U31	Integrated Circuit	807700	12040	74C192	1

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[1] 783733 units only
[2] 783784 units only
[3] +180° option
[4] Low frequency option

Replacement Parts List: Chassis Assembly (783733, 783784) (Continued)

Ref. Des.	Description	NAI Part No.	Mfr. Code	Mfr. Part No.	Total Qty
U32	Integrated Circuit	807702	04713	MC14561	1
U33[1]	Integrated Circuit	807703	12040	74C902	3
U33[2]	Integrated Circuit	808357	12040	DM81LS95N	4
U34[1]	Same as U33[1]				
U34[2]	Same as U33[2]				
U35[1]	Same as U33[1]				
U35[2]	Same as U33[2]				
U36[1]	Integrated Circuit	808012	12040	DS3630N	1
U36[2]	Same as U33[2]				
U37	I.C., Diode Bridge, 50V	807704	30870	VM08	2
U38	Same as U37				
U39	I.C., Diode Bridge, 400V	807705	30870	VM48	1
U40[1]	Integrated Circuit	807682	12040	LM340K-15	1
U40[2]	Integrated Circuit	808388	12040	LM340T-15	1
U41[1]	Integrated Circuit	807683	12040	LM320K-15	1
U41[2]	Integrated Circuit	808390	12040	LM320T-15	1
U42[1]	Integrated Circuit	807684	12040	LM340K-5	1
U42[2]	Integrated Circuit	808389	12040	LM340T-15	1
U201[7]	Integrated Circuit	807700-MOS	12040	74C192	1
U202[1,7]	Integrated Circuit	807703-MOS	12040	74C902	1
U203[7]	Integrated Circuit	807702-MOS	04713	14561	1
U204[7]	Integrated Circuit	808089	12040	LF13202	1
VP1	Varistor	807699	03508	V130LA10A	2
VP2	Same as VP1				
XU3	Same as J2				

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[1]783733 units only
[2]783784 units only
[7]Standard and low frequency option

Replacement Parts List: Low Frequency (.005° Resolution, 47-440Hz)(P/O Main Chassis 7P3733)

Ref. Des.	Description	NAI Part No.	Mfr. Code	Mfr. Part No.	Total Qty
C18	Capacitor, Ceramic .39µf, 50V, ±10%	808193	56289	5CX7R394X9100C5	3
C19	Same as C18				
C20	Capacitor, Ceramic .082µf, 100V, ±10%	808405	56289	CK06BX823K	1
C22	Same as C18				
C23	Capacitor, Ceramic 1000pf, 200V, ±10%	805850		CK05BX102K	1
R47	Resistor, Metal Film 4.02MΩ, 1/10W, ±1%	808095	01121	CC4024F	2
R48	Same as R47				
R113	Resistor, Metal Film 165kΩ, 1/10W, ±1%	808365	01121	CC1653F	1
R119	Resistor, Metal Film 41.2kΩ, 1/10W, ±1%	807695		RN55C4122F	1
T1	Transformer, Scott-T	807799	07342	807799	1
T3	Transformer, Reference	808148	07342	808148	1
U27	Integrated Circuit	808093-MOS	07263	34027	1

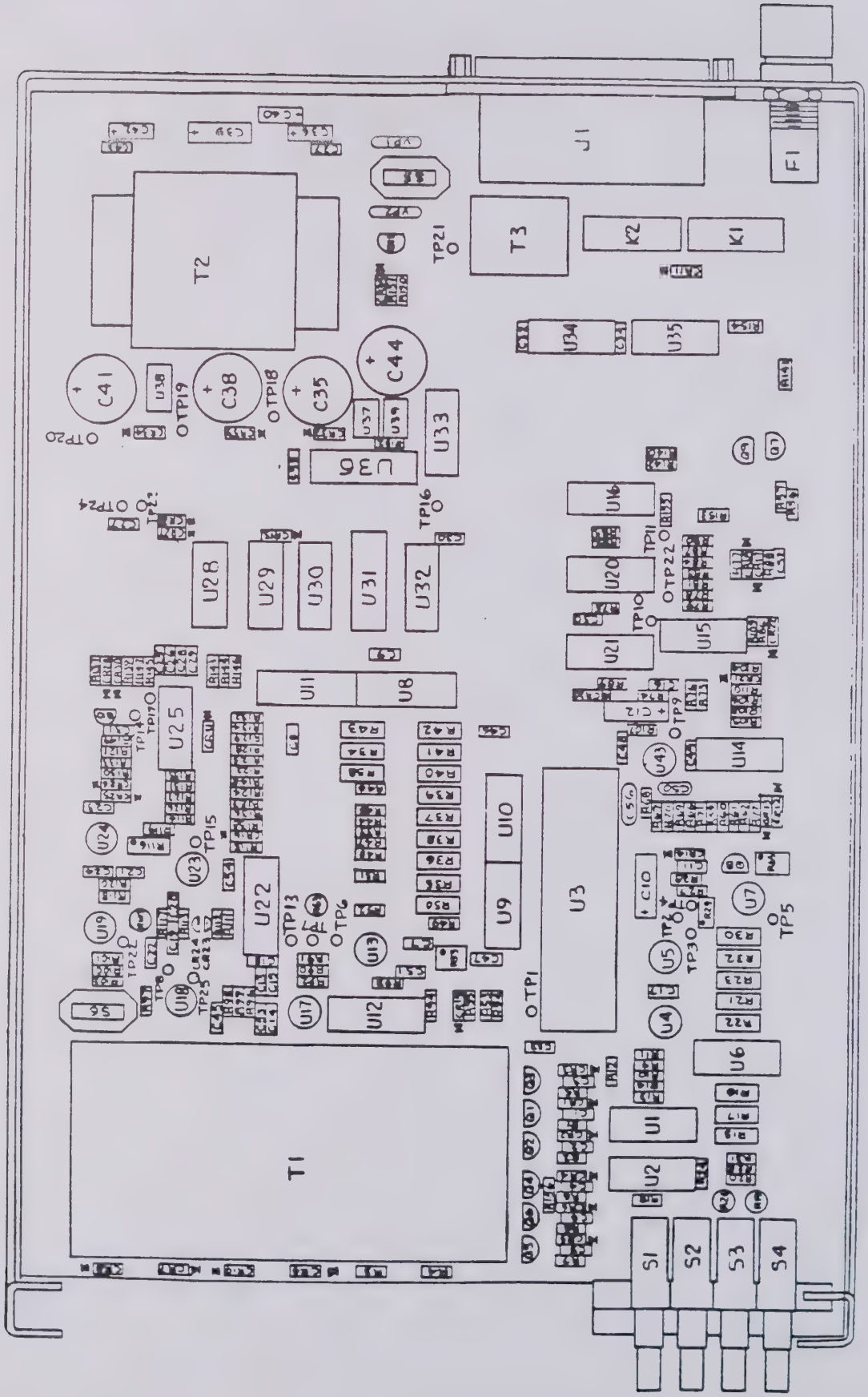

Figure 6-1. Main Chassis (±180° option) (783784), Parts Locator

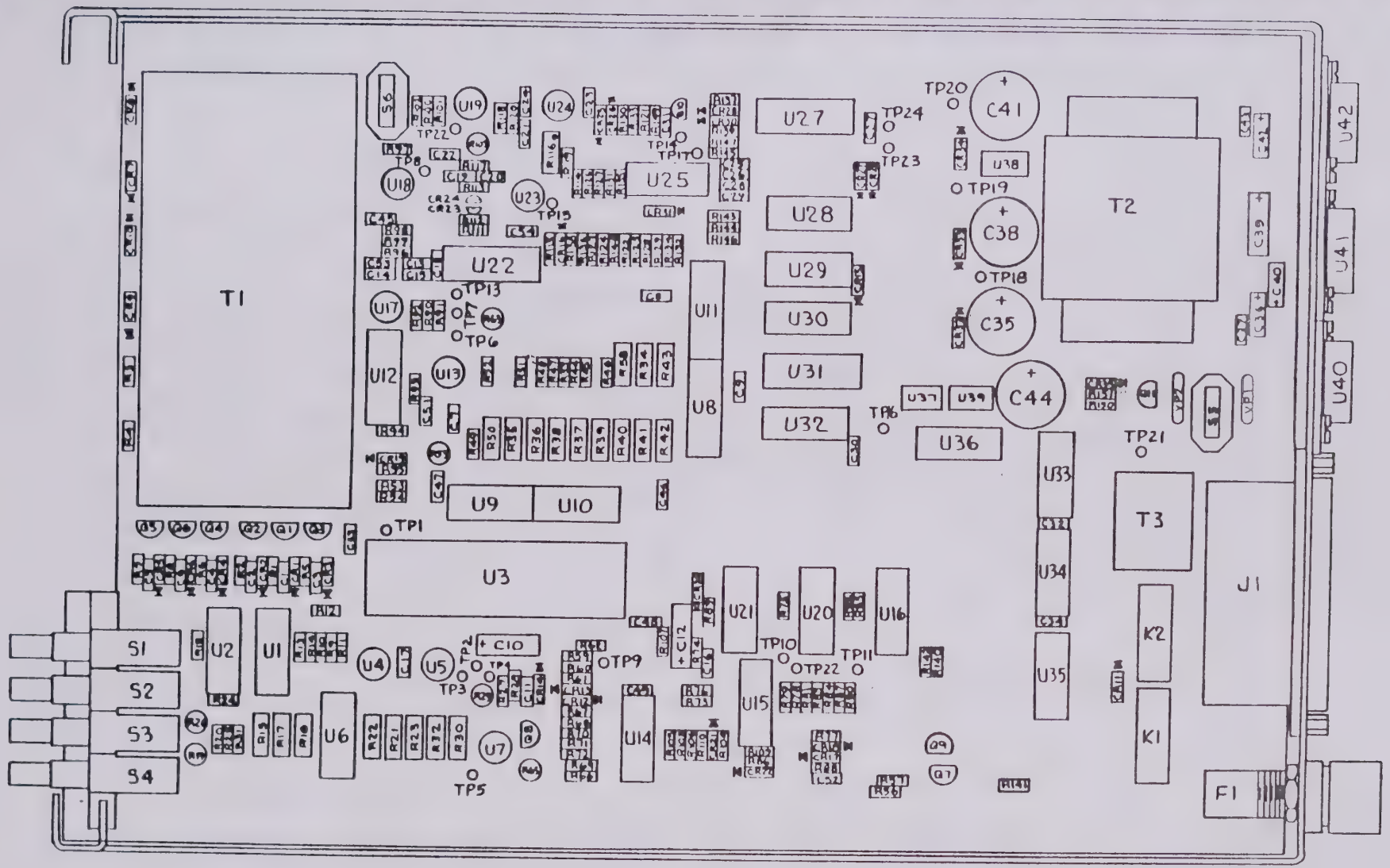

Figure 6-2. Main Chassis (Standard and Low Frequency, 0.005° Res.) (783733), Parts Locator

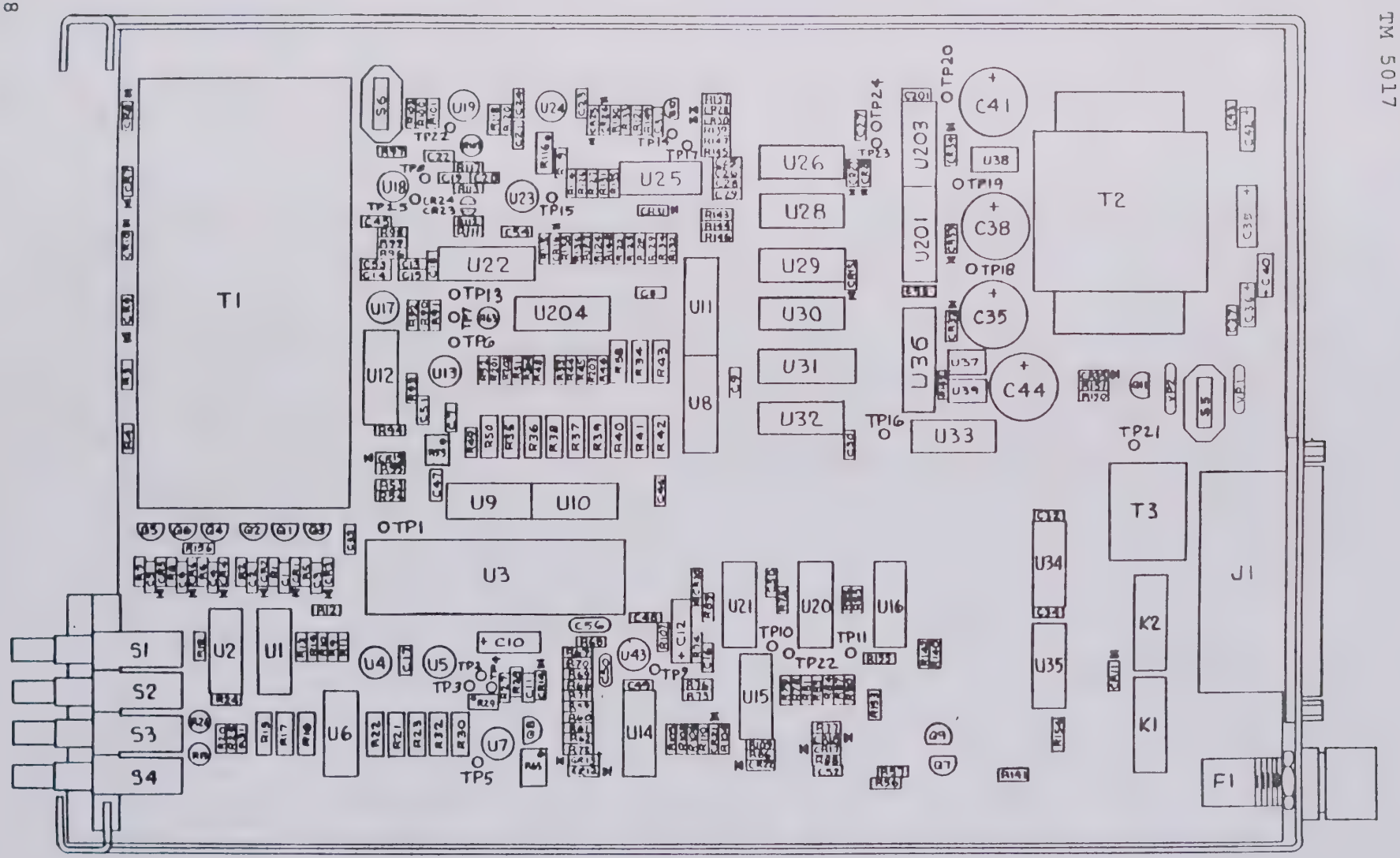

Figure 6-3. Main Chassis (Standard and Low Frequency Option) 783784, Parts Locator

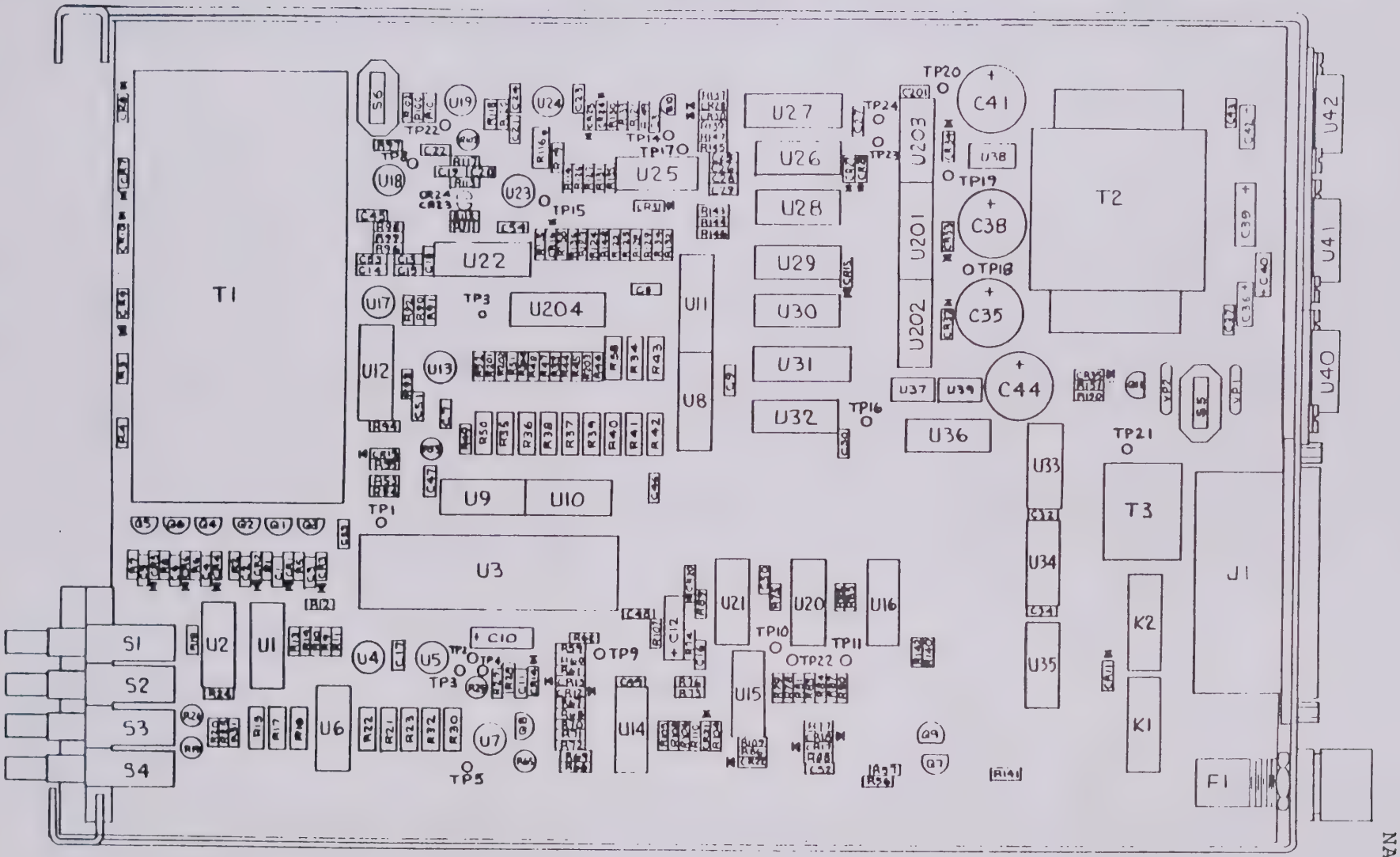

Figure 6-4. Main Chassis (Standard and Low Frequency Option) 783733, Parts Locator

Replacement Parts List - 360° Display Board, 783739

Ref. Des.	Description	NAI Part No.	Mfr. Code	Mfr. Part No.	Total Qty
DS1	Display, Readout	807670	73138	SP353	2
DS2	Same as DS1				
DS3	LED	807493	28480	5082-4484	3
DS4	Same as DS3				
DS5	Same as DS3				
R1	Resistor, Composition 430kΩ, 1/4W, ±5%	802519	01121	CB4345	1
R2	Resistor, Composition 2.2kΩ, 1/4W, ±5%	800079	01121	EB2225	6
R3	Same as R2				
R4	Same as R2				
R5	Same as R2				
R6	Same as R2				
R7	Same as R2				
R8	Resistor, Composition 13kΩ, 1/4W, ±5%	880094	01121	CB1335	6
R9	Same as R8				
R10	Same as R8				
R11	Same as R8				
R12	Same as R8				
R13	Same as R8				
R14	Resistor, Composition 150Ω, 1/4W, ±5%	880200	01121	CB1515	1
U1	Integrated Circuit	806945	07187	DD700	6
U2	Same as U1				
U3	Same as U1				
U4	Same as U1				
U5	Same as U1				
U6	Same as U1				
XDS1	Cable, Flat-flex, 16 cond.	808117	00779	5107-651-74	1
XDS2	Cable, Flat-flex, 14 cond.	808116	00779	5107-651-157	1
XDS1	Socket, Readout	807672	73138	CS353	2
XDS2	Same as XDS1				

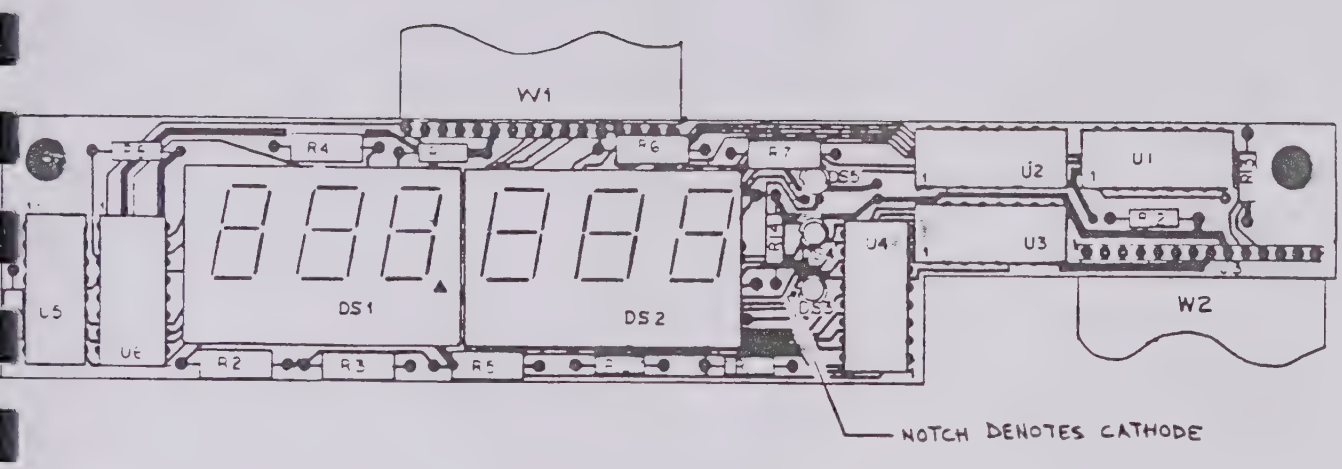

Figure 6-5. 360° Display Board (Standard), Parts Locator

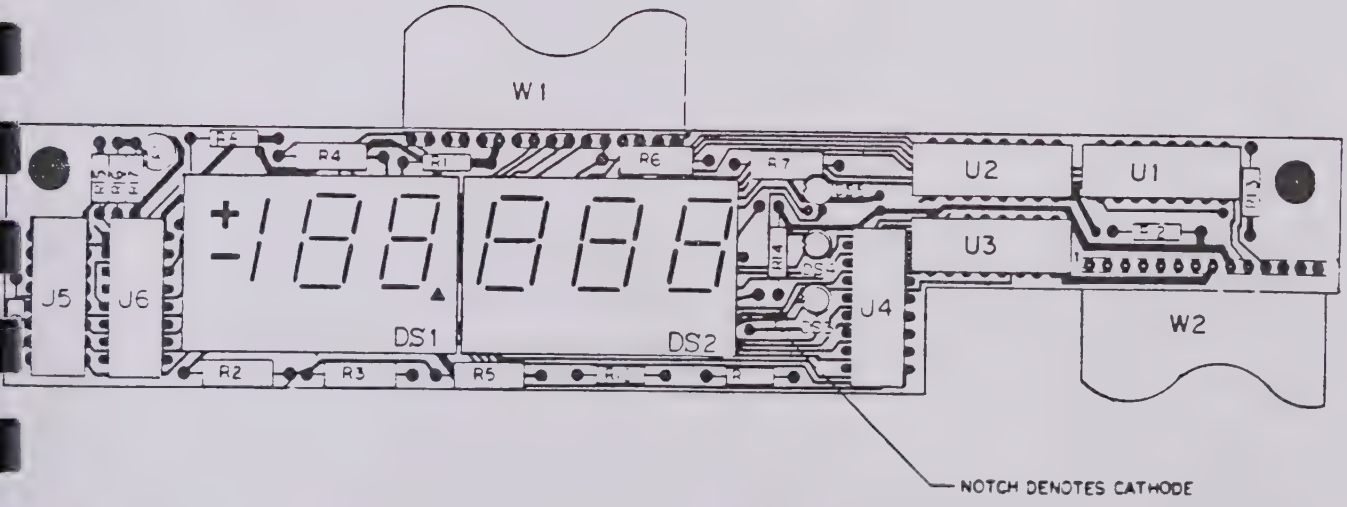

Figure 6-6. ±180° Display Board (Standard), Parts Locator

Replacement Parts List: ±180° Display Board - 783747

ef. es.	Description	NAI Part No.	Mfr. Code	Mfr. Part No.	Total Qty
S1	Display, Readout	808279	73138	SP354	1
S2	Display, Readout	807670	73138	SP353	1
S3	LED	807493	09182	5082-4484	3
S4	Same as DS3				
S5	Same as DS3				
1	Transistor, Signal	804088	04713	2N4123	1
1	Resistor, Composition 430kΩ, 1/4W, ±5%	802519	01121	CB4345	1
2	Resistor, Composition 2.2kΩ, 1/2W, ±5%	800079	01121	EB2225	6
3	Same as R2				
4	Same as R2				
5	Same as R2				
6	Same as R2				
7	Same as R2				
8	Resistor, Composition 13kΩ, 1/4W, ±5%	802186	01121	CB1335	6
9	Same as R8				
10	Same as R8				
11	Same as R8				
12	Same as R8				
13	Same as R8				
14	Resistor, Composition 150kΩ, 1/4W, ±5%	803672	01121	CB1515	1
15	Resistor, Composition 27kΩ, 1/8W, ±5%	808278	01121	BB2735	
16	Resistor, Composition 10kΩ, 1/8W, ±5%	880830	01121	BB1035	1
17	Resistor, Composition 4.7kΩ, 1/8W, ±5%	880829	01121	BB4721	1
1	Integrated Circuit	806945	07187	DD700	5
2	Same as U1				
3	Same as U1				
4	Same as U1				
5	Same as U1				
6	Integrated Circuit	807761	07187	DD702	1

Replacement Parts List: ±180° Display Board - 783747 (Continued)

Ref. Des.	Description	NAI Part No.	Mfr. Code	Mfr. Part No.	Total Qty
W1	Cable, Flat-flex, 16-cond.	808117	00779	5107-651-74	1
W2	Cable, Flat-flex, 14-cond.	808116	00779	5107-651-157	1
XDS1	Socket, Readout	807672	73138	CS353	2
XDS2	Same as XDS1				

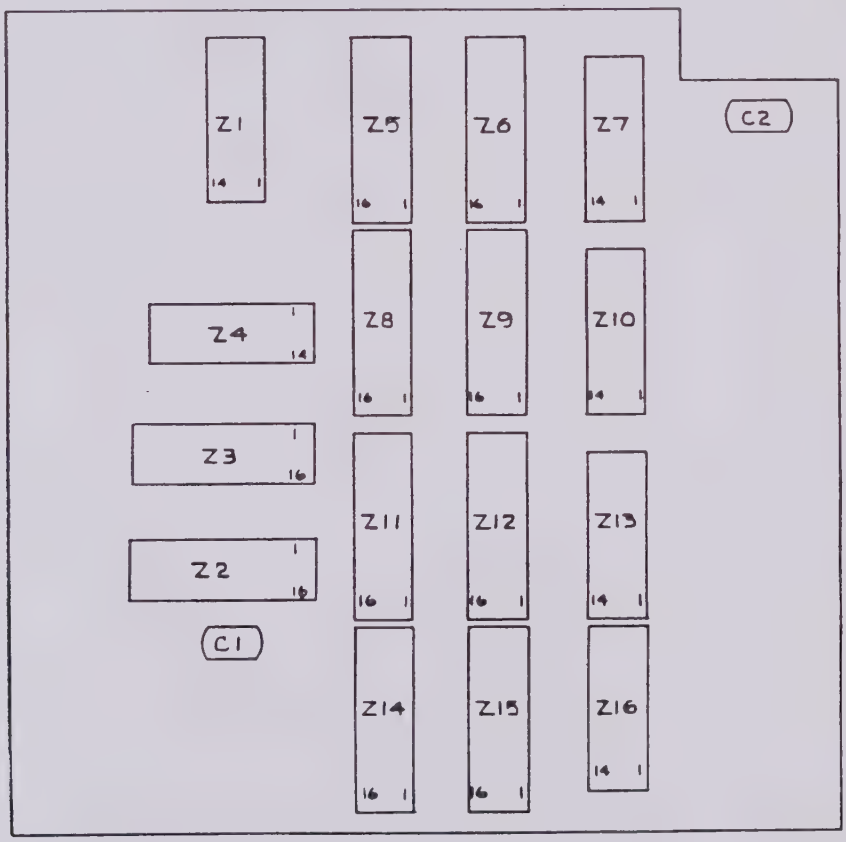

Figure 6-7. ±180° Digital Board, Parts Locator

Replacement Parts List: ±180° Digital Board - 783719

ef. es.	Description	NAI Part No.	Mfr. Code	Mfr. Part No.	Total Qty
1	Capacitor, Ceramic .01µf, 25V, +80-20%	803406	72982	5835-000-Y5U103Z	2
2	Same as C1				
Z1	Socket, I.C., 14-pin	807473	01295	C931402	6
Z2	Socket, I.C., 16-pin	807474	01295	C931602	10
Z3	Same as XZ2				
Z4	Same as XZ1				
Z5	Same as XZ2				
Z6	Same as XZ2				
Z7	Same as XZ1				
Z8	Same as XZ2				
Z9	Same as XZ2				
Z10	Same as XZ1				
Z11	Same as XZ2				
Z12	Same as XZ2				
Z13	Same as XZ1				
Z14	Same as XZ2				
Z15	Same as XZ2				
Z16	Same as XZ1				
1	Integrated Circuit	807701-MOS	12040	74C00	1
2	Integrated Circuit	807780-MOS	04713	MC14519CP	5
3	Integrated Circuit	807779-MOS	04713	MC14560CP	5
4	Integrated Circuit	807702-MOS	04713	MC14561	5
5	Same as Z1				
6	Same as Z3				
7	Same as Z4				
8	Same as Z2				
9	Same as Z3				
10	Same as Z4				
11	Same as Z2				
12	Same as Z3				
13	Same as Z4				
14	Same as Z2				
15	Same as Z3				
16	Same as Z4				

Replacement Parts List: Lower Chassis Assembly 500916 - IEEE Option

Ref. Des.	Description	NAI Part No.	Mfr. Code	Mfr. Part No.	Total Qty
	IEEE Interface Assembly (Prime Board)	783777-04			
C201	Capacitor, Elect. Tantalum 13,000µf, 15V	804185	56289	36D133G015AC2A	1
	Switch, 5-Pos	808275	00779	435626-9	1
T201	Transformer, Power	808309	08779	DFC16-1500	1
D201	Diode, Bridge Rectifier	804332	30870	VS243	1
U202	Voltage Regulator	808205	12040	LM323K	1
	IEEE Interface Cable Assy.	783776			
J5	Connector, 50-pin	807616	07342	807616	1
J1	Connector Kit, 50-pin	783718	07342	783718	1
P7	Connector, EECO	882094	97525	H-4920-01	1
	IEEE Interface Cable J1	783781			
J6	Connector, 24-pin	205964	07342	205964	1
	Connector, 14-pos	808383	22526	65350-001	1
	Connector, 34-pin	808385	28218	3414-3000	1

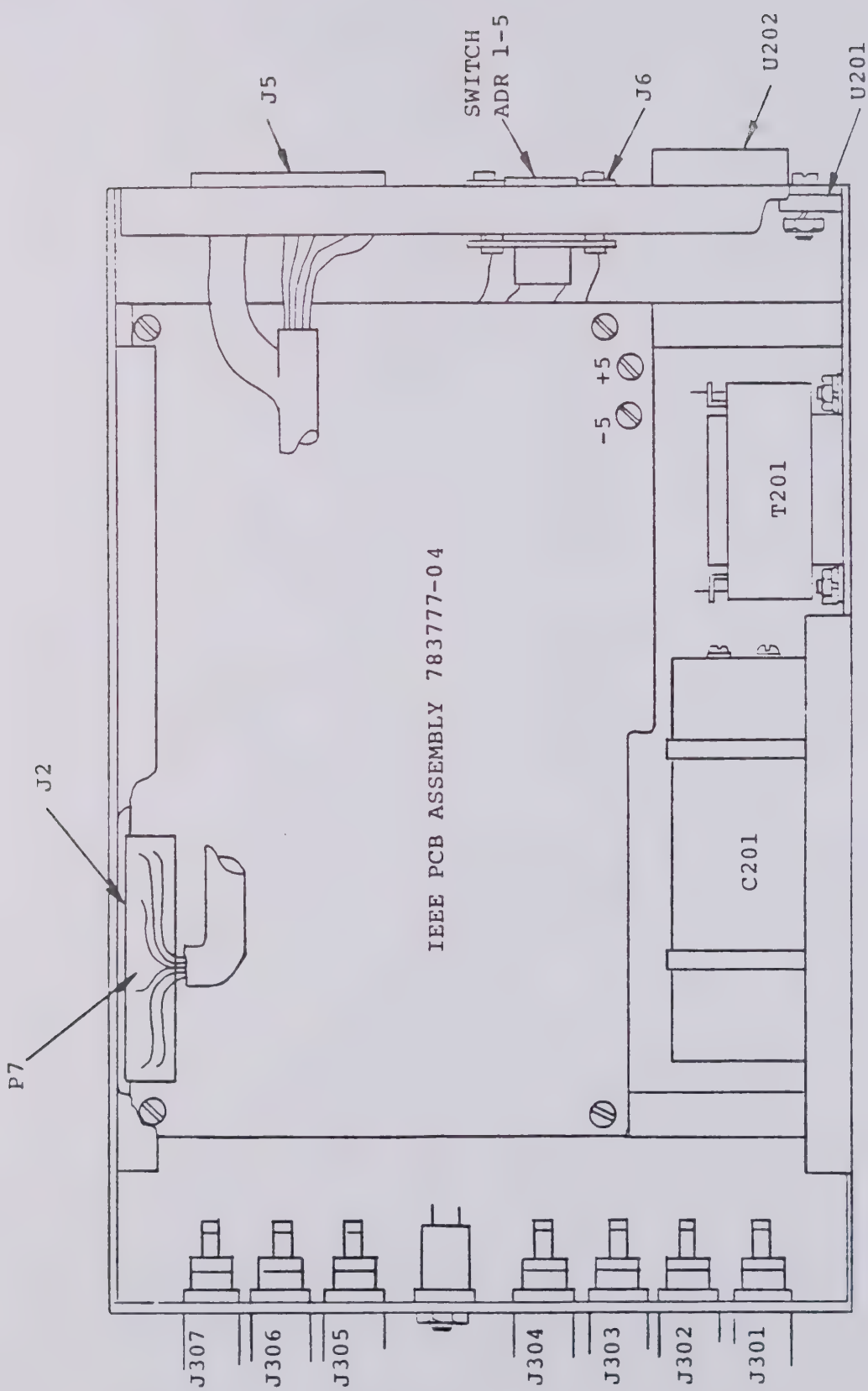

Figure 6-8. Lower Chassis (IEEE Option), Parts Locator

Replacement Parts List - IEEE Interface (Prime Board) - 783777-02

Ref. Des.	Description	NAI Part No.	Mfr. Code	Mfr. Part No.	Total Qty
C1	Capacitor, Tantalum 10µf, 25V, ±10%	808259	06751	TS2K-25-106K	2
C2	Same as C1				
C3	Capacitor, Ceramic .01µf, 25V, +80-20%	803406	72982	5835-000-Y5U-103Z	28
C4	Same as C3				
C5	Same as C3				
C6	Same as C3				
C7	Same as C3				
C8	Same as C3				
C9	Same as C3				
C10	Same as C3				
C11	Same as C3				
C12	Same as C3				
C13	Same as C3				
C14	Same as C3				
C15	Same as C3				
C16	Same as C3				
C17	Not used				
C18	Same as C3				
C19	Same as C3				
C20	Same as C3				
C21	Same as C3				
C22	Same as C3				
C23	Same as C3				
C24	Same as C3				
C25	Same as C3				
C26	Same as C3				
C27	Same as C3				
C28	Same as C3				
C29	Same as C3				
C30	Same as C3				
C31	Same as C3				

Replacement Parts List: IEEE Interface (Prime Board - 783777-02 (Continued)

ef. es.	Description	NAI Part No.	Mfr. Code	Mfr. Part No.	Total Qty
32	Capacitor, Ceramic .1µf, 12V, ±20%	880636	72982	5655-000-Y5F-0104M	2
33	Same as C32				
34	Capacitor, Ceramic .47µf, 50V, ±20%	807294	72982	8131-050-651-474M	1
R1	Diode	806330		JAN 1N914	1
1	Resistor, Composition 100Ω, 1/4W, ±5%	801981	01121	CB1015	1
2	Not used				
3	Resistor, Composition 3.3kΩ, 1/4W, ±5%	803388	01121	CB3325	3
4	Same as R3				
5	Resistor, Composition 4.7kΩ, 1/4W, ±5%	880088	01121	CB4725	1
6	Resistor, Composition 2MΩ, 1/4W, ±5%	807094	01121	CB2055	2
7	Same as R6				
8	Same as R3				
1	Integrated Circuit	808412	01295	SN75452BP	1
3	Integrated Circuit	808342	01295	74LS125N	2
4	Integrated Circuit	808421	04713	MC6802P	1
5	Integrated Circuit	808373	01295	74LS244N	2
6	Same as U5				
7	Integrated Circuit	808374	01295	74LS243N	2
8	Same as U7				
9	Integrated Circuit	808341	01295	74LS04N	1
10	Integrated Circuit	808137	01295	74LS00N	2
11	Integrated Circuit	808131	04713	MC6820P	1
12	Integrated Circuit	808339	04713	MC3440P	2
13	Same as U12				
14	Same as U10				
15	Integrated Circuit	808127	01295	74LS32N	2
16	Integrated Circuit	808139	04713	MC3441P	2
17	Same as U16				
19	Integrated Circuit Resistor Network, 1kΩ	808371	56289	216CH102X2PD	1

Replacement Parts List: IEEE Interface (Prime Board) - 783777-02 (Continued)

Ref. Des.	Description	NAI Part No.	Mfr. Code	Mfr. Part No.	Total Qty
U20	Integrated Circuit	808411	01295	NE555P	1
U21	Integrated Circuit	808135	02195	74LS138N	2
U22	Same as U21				
U23 *	Integrated Circuit (Programmed)	885062-01	07342	885064-01	1
U24 *	Integrated Circuit (Programmed)	885064-02	07342	885064-02	1
U29	Integrated Circuit	808344	01295	74LS253N	4
U30	Same as U29				
U31	Same as U29				
U32	Same as U29				
U33	Integrated Circuit	808343	01295	74LS173N	2
U34	Same as U33				
U35	Integrated Circuit Resistor Network, 10kΩ	808410	73138	785-1-R10K	1
U36	Same as U15				
Y1	Crystal, 4MHz	808336	12749	CY3A	1

* © North Atlantic Industries 1982

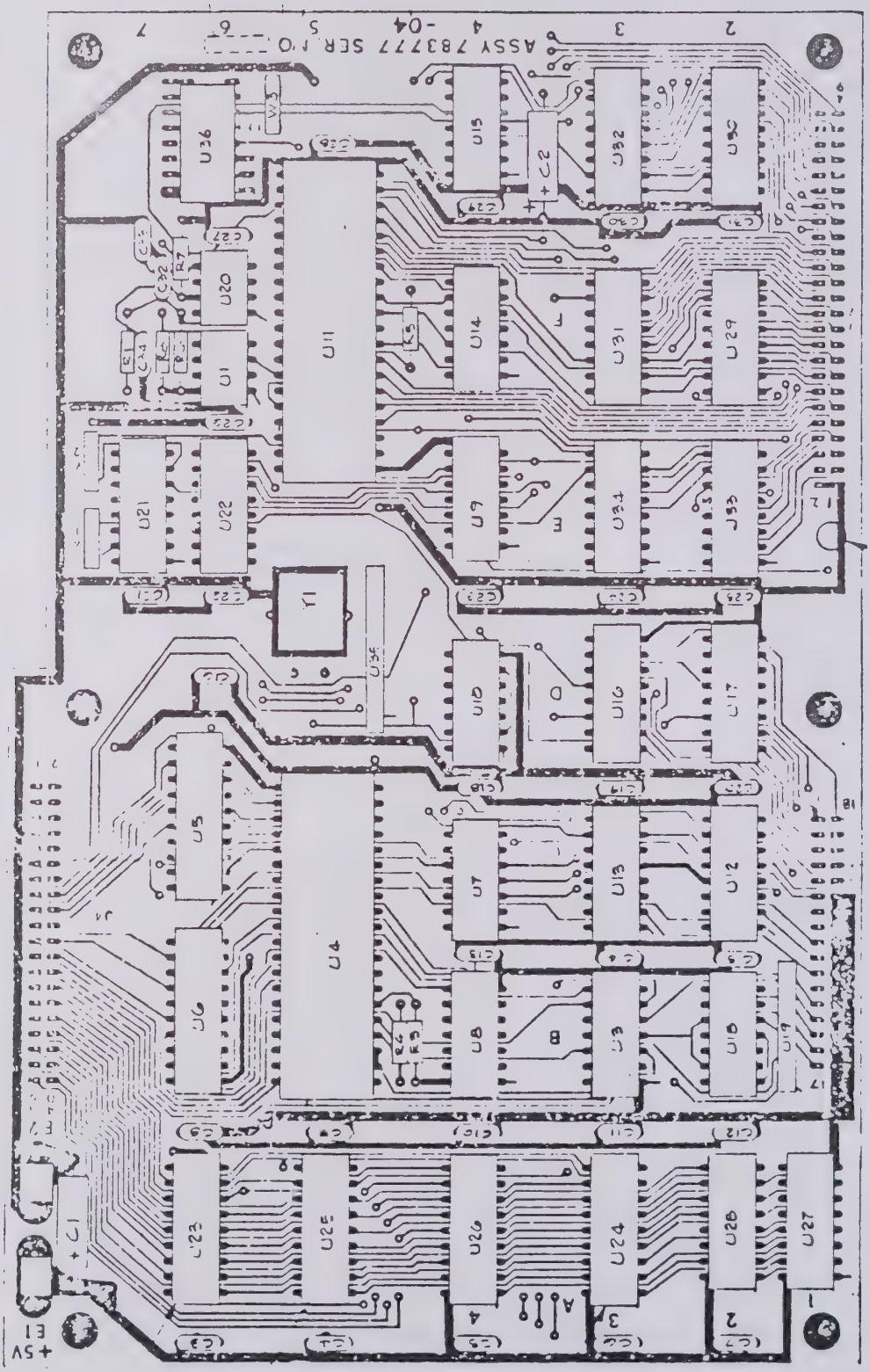

Figure 6-9. IEEE Interface 783777-04, Parts Locator

Replacement Parts List: IEEE Interface (Prime Board) - 783777-04

Ref. Des.	Description	NAI P/N	Mfr. Code	MFR P/N	Qty
	Sub-Assembly	500928-1			
C1	Capacitor, Elect. Tantalum 10µf, 25V, ±10%	808259	56289	138D106X9025CZ	2
C2	Same as C1				
C6	Capacitor, Ceramic .1µf, 12V, +80-20%	803406	72982	5835-000-Y5U-103Z	25
C7	Same as C6				
C8	Same as C6				
C9	Same as C6				
C10	Same as C6				
C11	Same as C6				
C12	Same as C6				
C13	Same as C6				
C14	Same as C6				
C15	Same as C6				
C16	Same as C6				
C18	Same as C6				
C19	Same as C6				
C20	Same as C6				
C21	Same as C6				
C22	Same as C6				
C23	Same as C6				
C24	Same as C6				
C25	Same as C6				
C26	Same as C6				
C27	Same as C6				
C28	Same as C6				
C29	Same as C6				
C30	Same as C6				
C31	Same as C6				
C32	Capacitor, Ceramic .1µf, 12V, ±20%	880636	72982	5655-000-Y5F0-104M	2
C33	Same as C32				
C34	Capacitor, Ceramic .47µf, 50V, ±20%	880817	71590	CY20C474M	1
CR1	Diode	882195		JAN IN914	1
R1	Resistor, Composition 100 ohm, 1/4W, ±5%	801981	01121	CB1015	1

Replacement Parts List: IEEE Interface (Prime Board) - 783777-04 (Continued)

Ref. Des.	Description	NAI Part No.	Mfr. Code	Mfr. Part No.	Total Qty
	Resistor, Composition 3.3kΩ, 1/4W, ±5%	803388	01121	CB3325	3
	Same as R3				
	Resistor, Composition 4.7kΩ, 1/4W, ±5%	880088	01121	CB4725	1
	Resistor, Composition 2MΩ, 1/4W, ±5%	807094	01121	CB2055	2
	Same as R6				
	Same as R3				
	Integrated Circuit	808412	01295	SN75452BP	1
	Integrated Circuit	808342	01295	74LS125N	2
	Integrated Circuit	808421	04713	MC6802P	1
	Integrated Circuit	808373	01295	74LS244N	2
	Same as U5				
	Integrated Circuit	808374	01295	74LS243N	2
	Same as U7				
	Integrated Circuit	808341	01295	74LS04N	1
C	Integrated Circuit	808137	01295	74LS00N	2
1	Integrated Circuit	808131	04713	MC6820P	1
2	Integrated Circuit	808339	04713	MC3440P	2
3	Same as U12				
4	Same as U10				
5	Integrated Circuit	808127	01295	74LS32N	2
6	Integrated Circuit	808139	04713	MC3441P	2
7	Same as U16				
8	Same as U3				
9	I.C., Resistor Network 1K	808371	56289	216CH102X2PD	1
C	Integrated Circuit	808411	01295	NE555P	1
1	Integrated Circuit	808135	01295	74LS138N	2
2	Same as U21				
3*	Integrated Circuit, Prog.	808997			1
9	Integrated Circuit	808344	01295	74LS253N	4
10	Same as U29				

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Replacement Parts List: IEEE Interface (Prime Board) - 783777-04 (Continued)

Ref. Des.	Description	NAI Part No.	Mfr. Code	Mfr. Part No.	Total Qty
U31	Same as U29				
U32	Same as U29				
U33	Integrated Circuit	808343	01295	74LS173N	2
U34	Same as U33				
U35	I.C., Resistor Network 10K	808410	73138	785-1-R10K	1
U36	Same as U15				
XU1	Socket, 8-pin	808406	09922	DILB8P-108	2
XU3	Socket, 14-pin	807473	01295	C931402	9
XU4	Socket, 40-pin	808409	18677	US-2-40-110NB	2
XU5	Socket, 20-pin	808408	09922	DILB20P-108	2
XU6	Same as XU5				
XU7	Same as XU3				
XU8	Same as XU3				
XU9	Same as XU3				
XU10	Same as XU3				
XU11	Same as XU4				
XU12	Socket, 16-pin	807474	01295	C931602	12
XU13	Same as XU12				
XU14	Same as XU12				
XU15	Same as XU3				
XU16	Same as XU12				
XU17	Same as XU12				
XU18	Same as XU3				
XU20	Same as XU1				
XU21	Same as XU12				
XU22	Same as XU12				
XU23	Socket, 24-pin	808004	00779	530018-1	2
XU24	Same as XU23				
XU29	Same as XU12				
XU30	Same as XU12				
XU31	Same as XU12				
XU32	Same as XU12				
XU33	Same as XU12				
XU34	Same as XU12				
XU36	Same as XU3				
Y1	Crystal, 3 MHz	808336	12749	CY3A	1

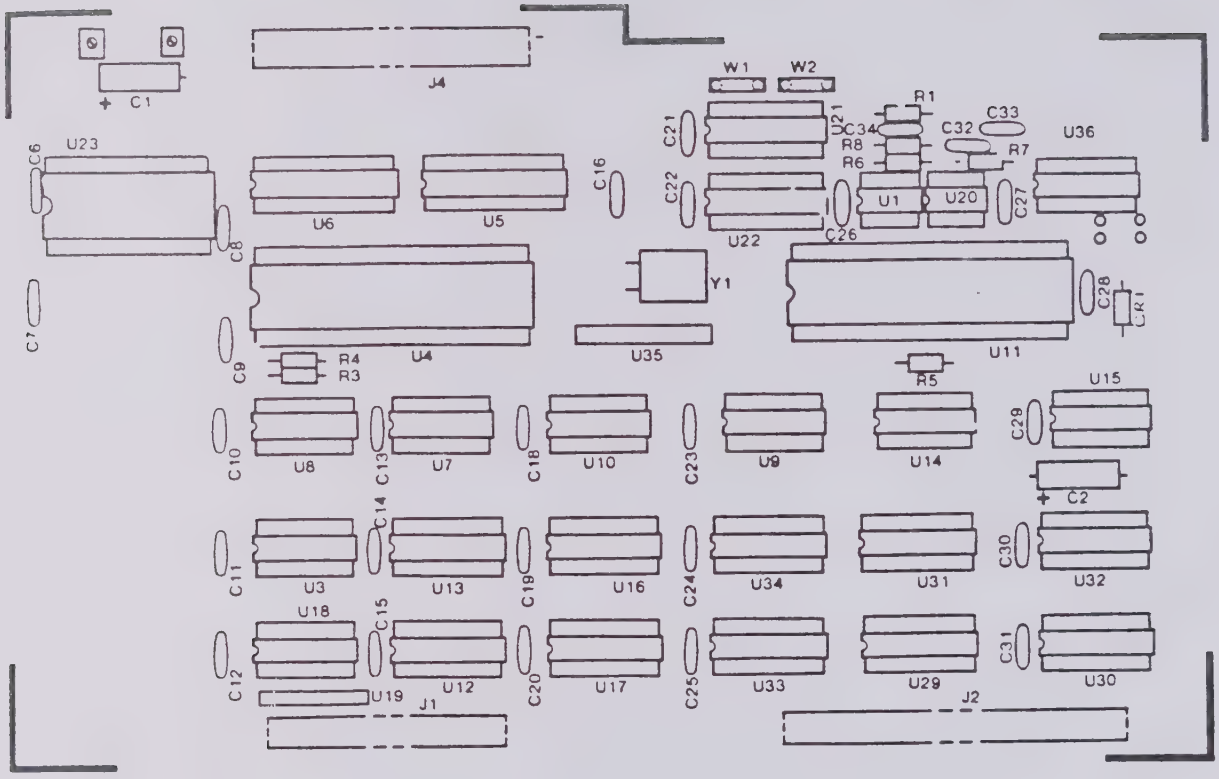


Figure 6-10. IEEE Interface 783777-04, Parts Locator

SECTION 7

UNIT SCHEMATICS

This section contains schematic diagrams for the basic and optional units of the API.

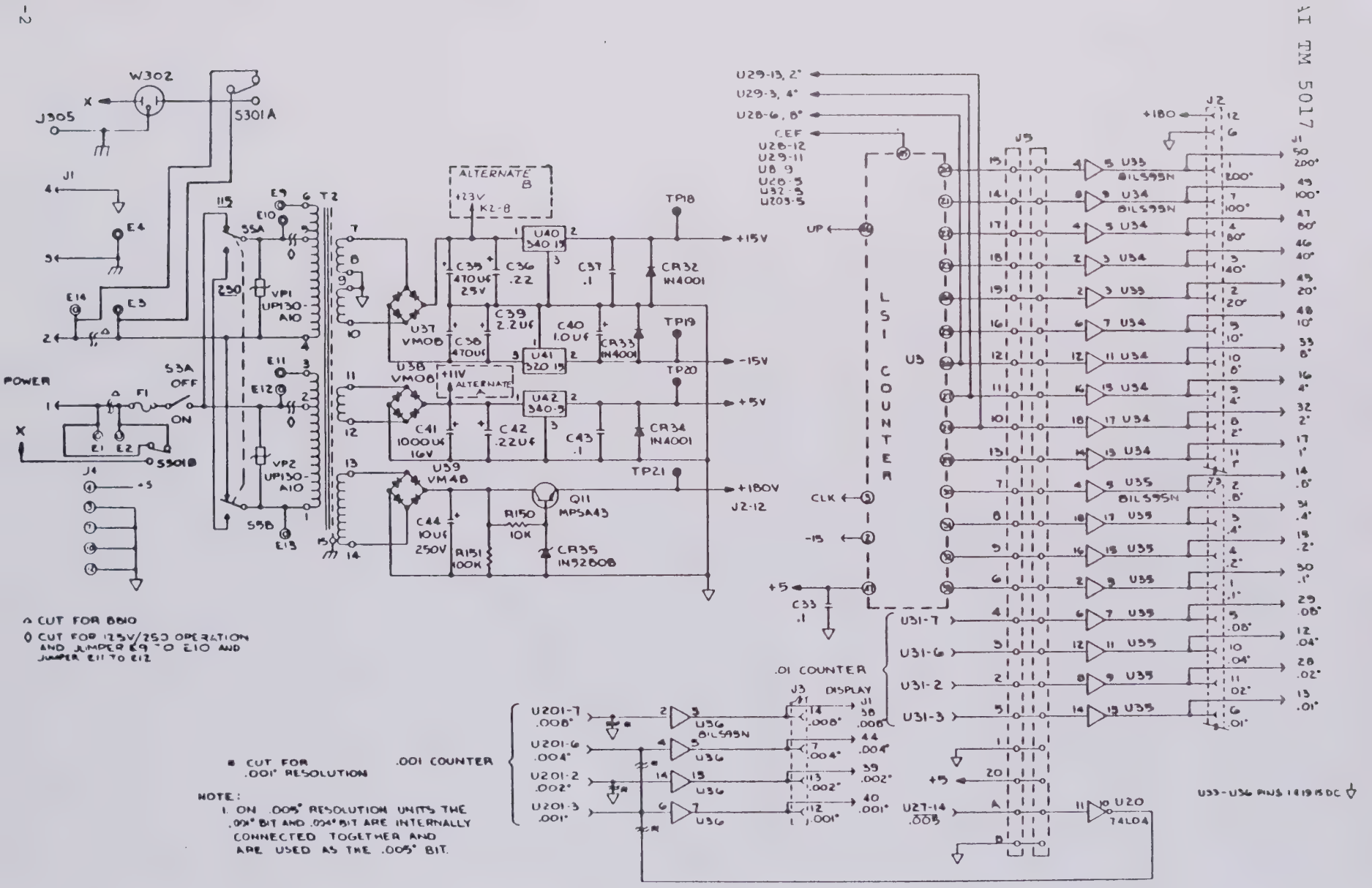


Figure 7-1. Main Chassis (Power Supply and Output Buffers)(783784)
(Sheet 1 of 5), Schematic

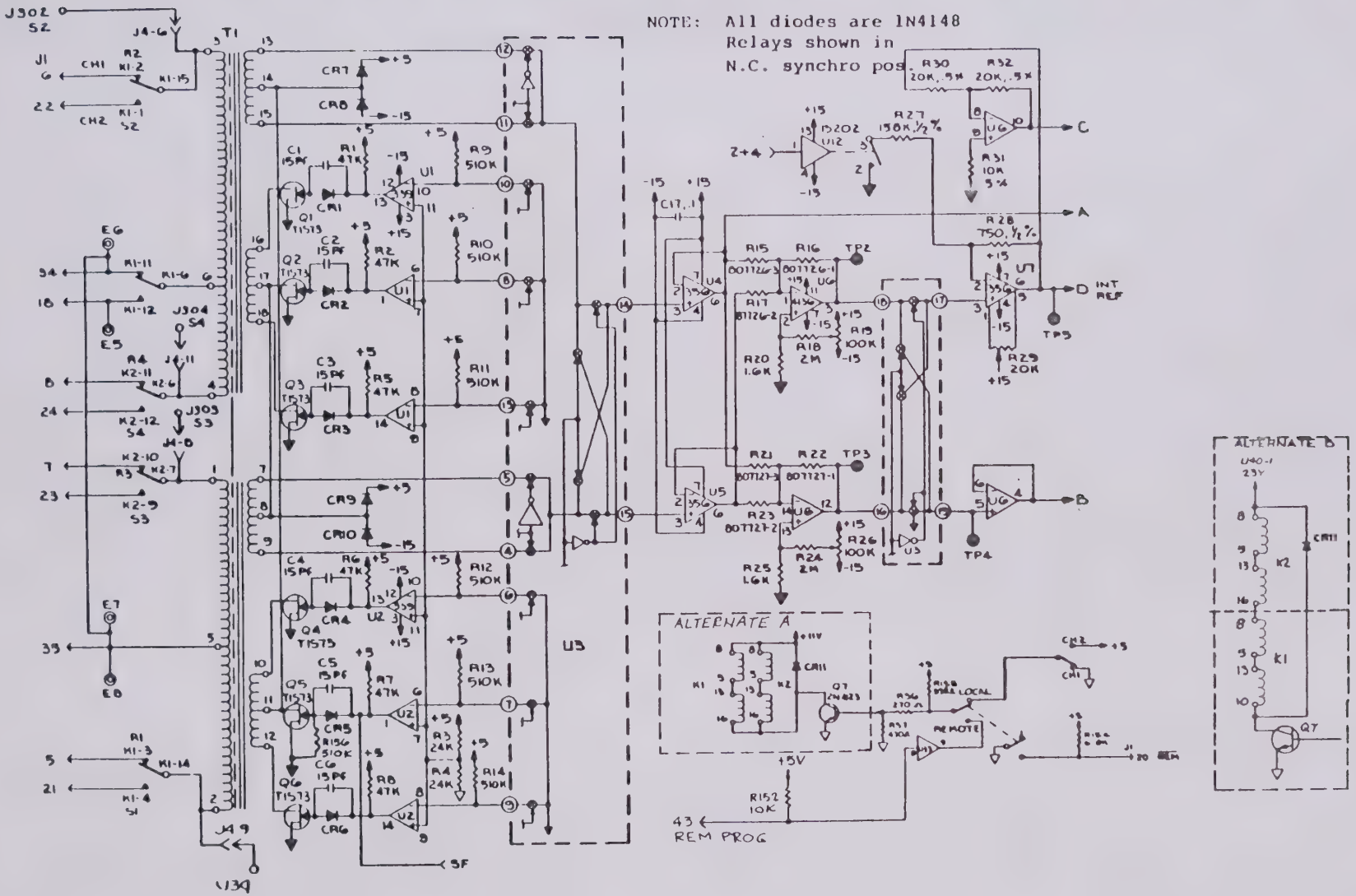


Figure 7-1. Main Chassis (Coarse Bridge and Precision Reference Generator) (783784) (Sheet 2 of 5), Schematic

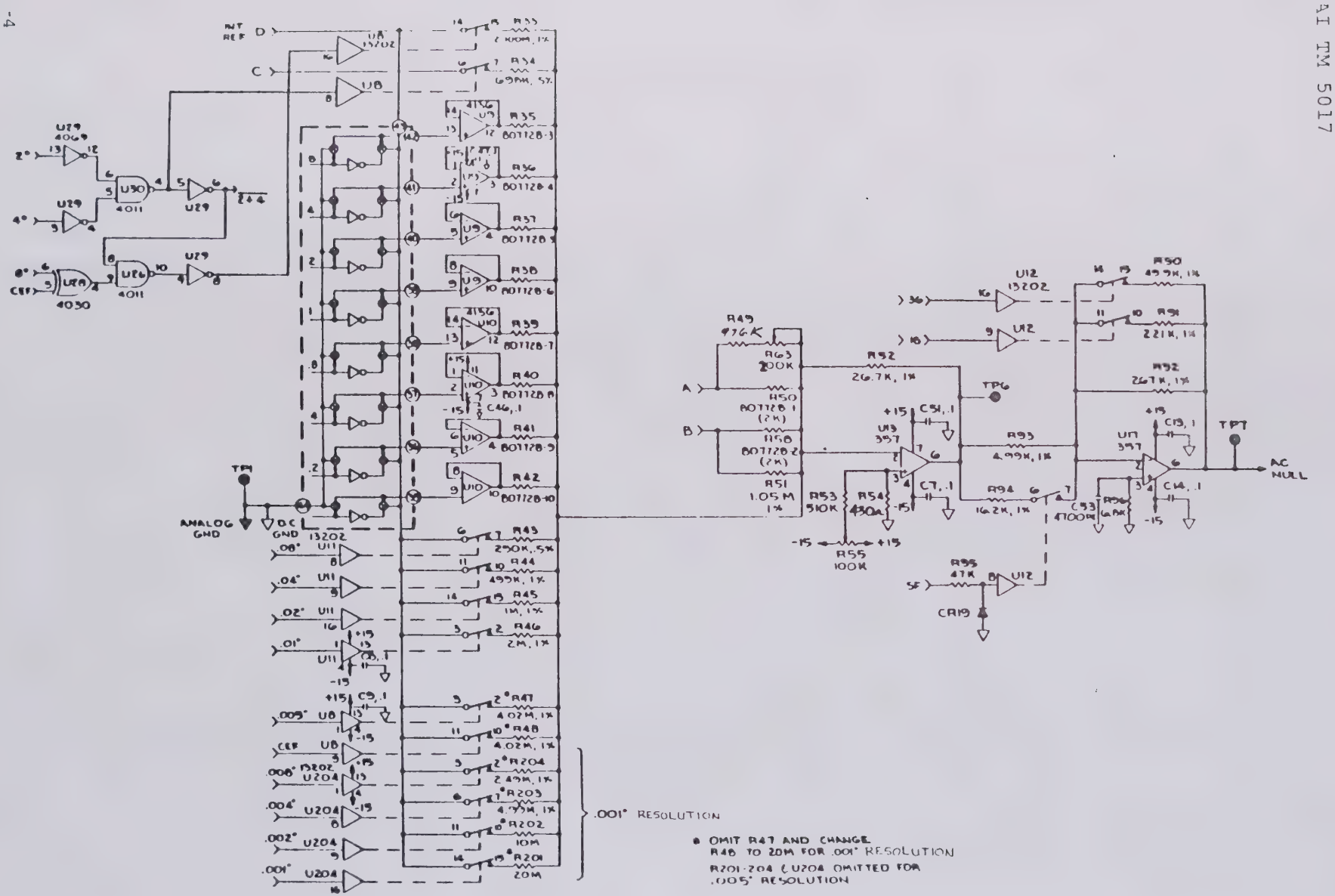


Figure 7-1. Main Chassis (Interpolation Ladder, Summing Amplifier and ac Amplifier) (783784) (Sheet 3 of 5), Schematic

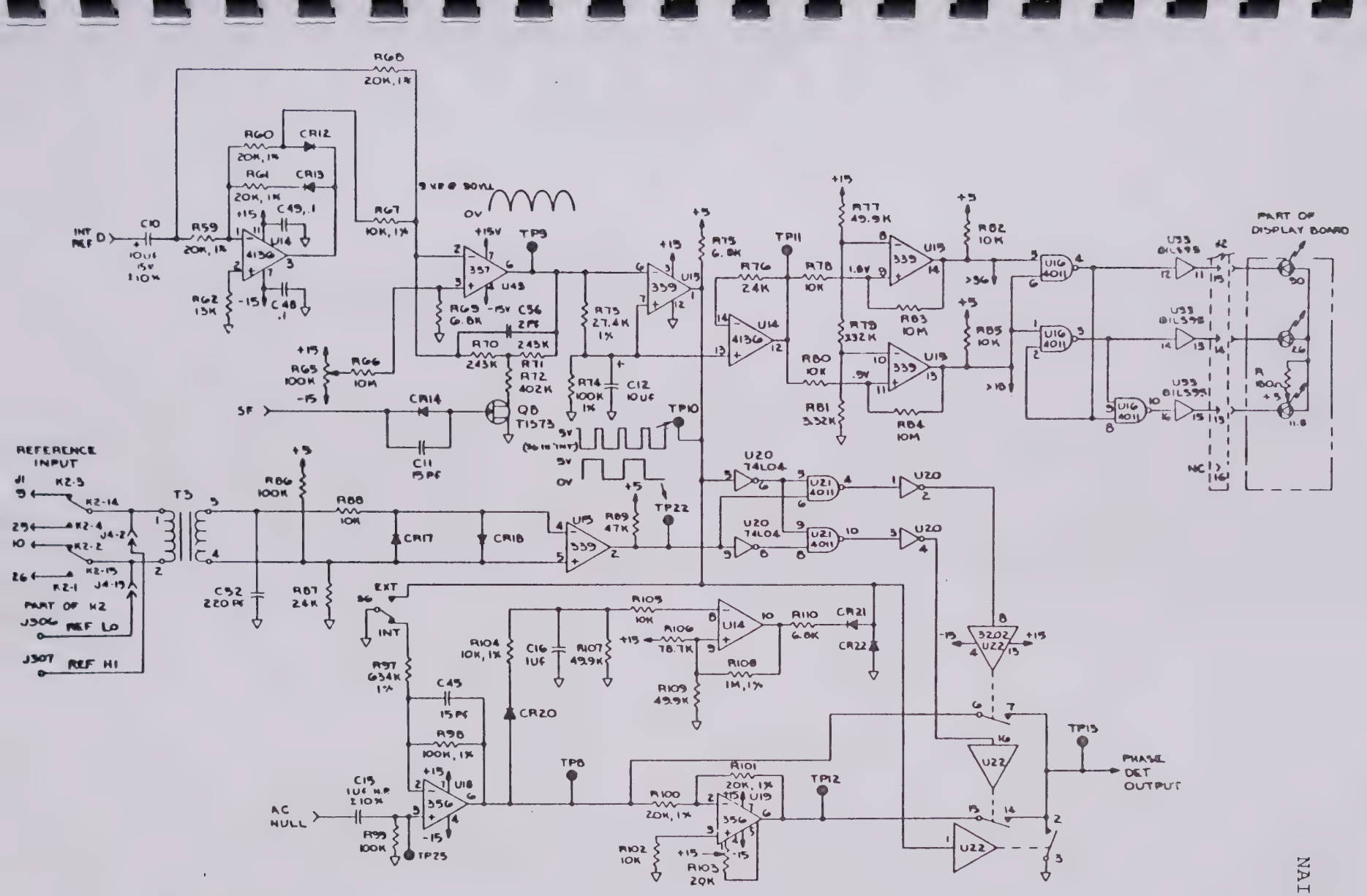
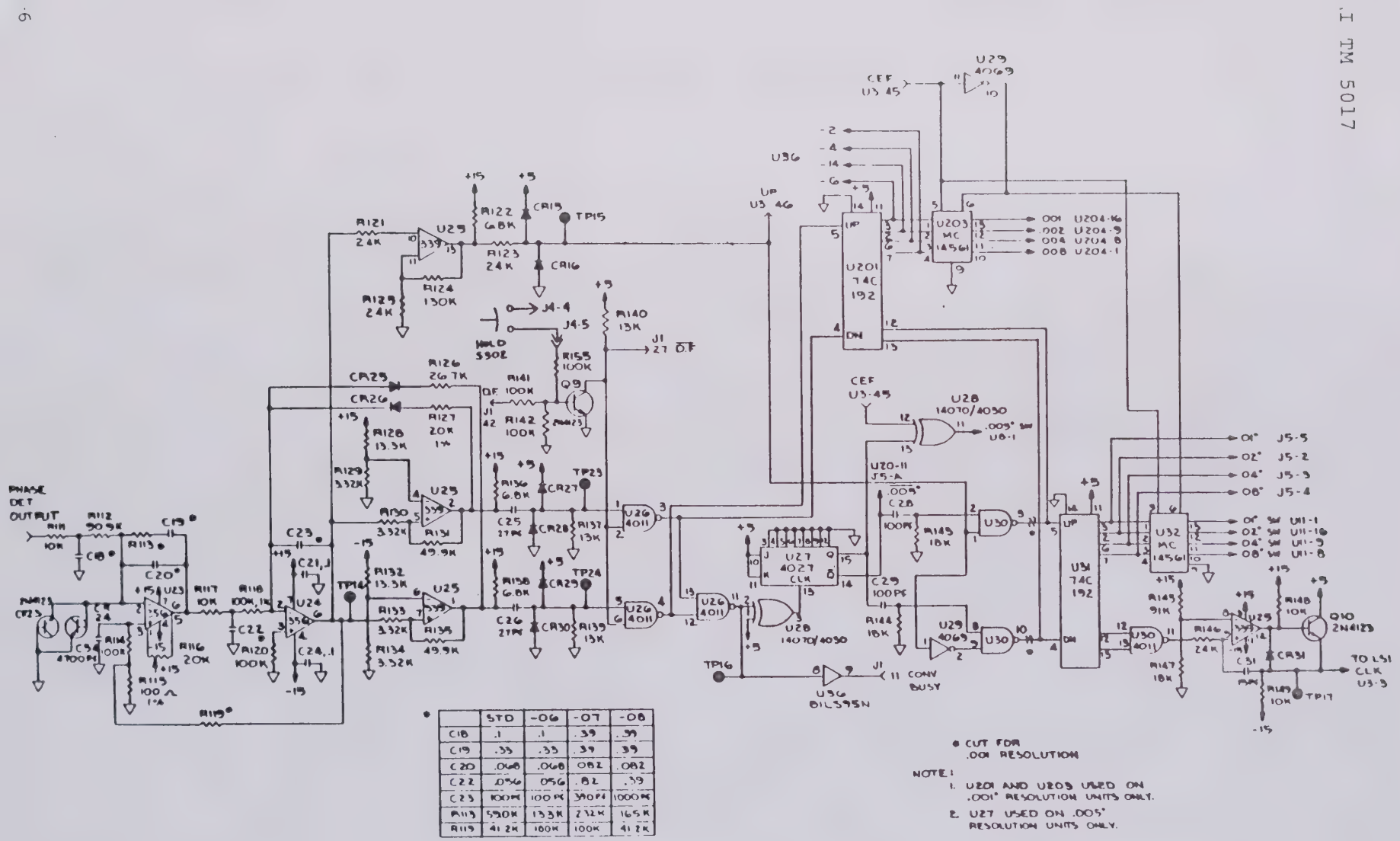


Figure 7-1. Main Chassis (Phase Detector and Internal Reference Circuit) (783784) (Sheet 4 of 5), Schematic



	STD	-06	-07	-08
C18	.1	.1	.39	.39
C19	.33	.33	.39	.39
C20	.068	.068	.082	.082
C22	.056	.056	.82	.39
C23	100PF	100PF	390PF	1000PF
R113	590K	133K	232K	165K
R119	41.2K	100K	100K	41.2K

* CUT FOR .001 RESOLUTION

NOTE:
1. U201 AND U203 USED ON .001" RESOLUTION UNITS ONLY.
2. U27 USED ON .005" RESOLUTION UNITS ONLY.

Figure 7-1. Main Chassis (First Integrator, VCO -Second Integrator and Counters) (783784) (Sheet 5 of 5), Schematic

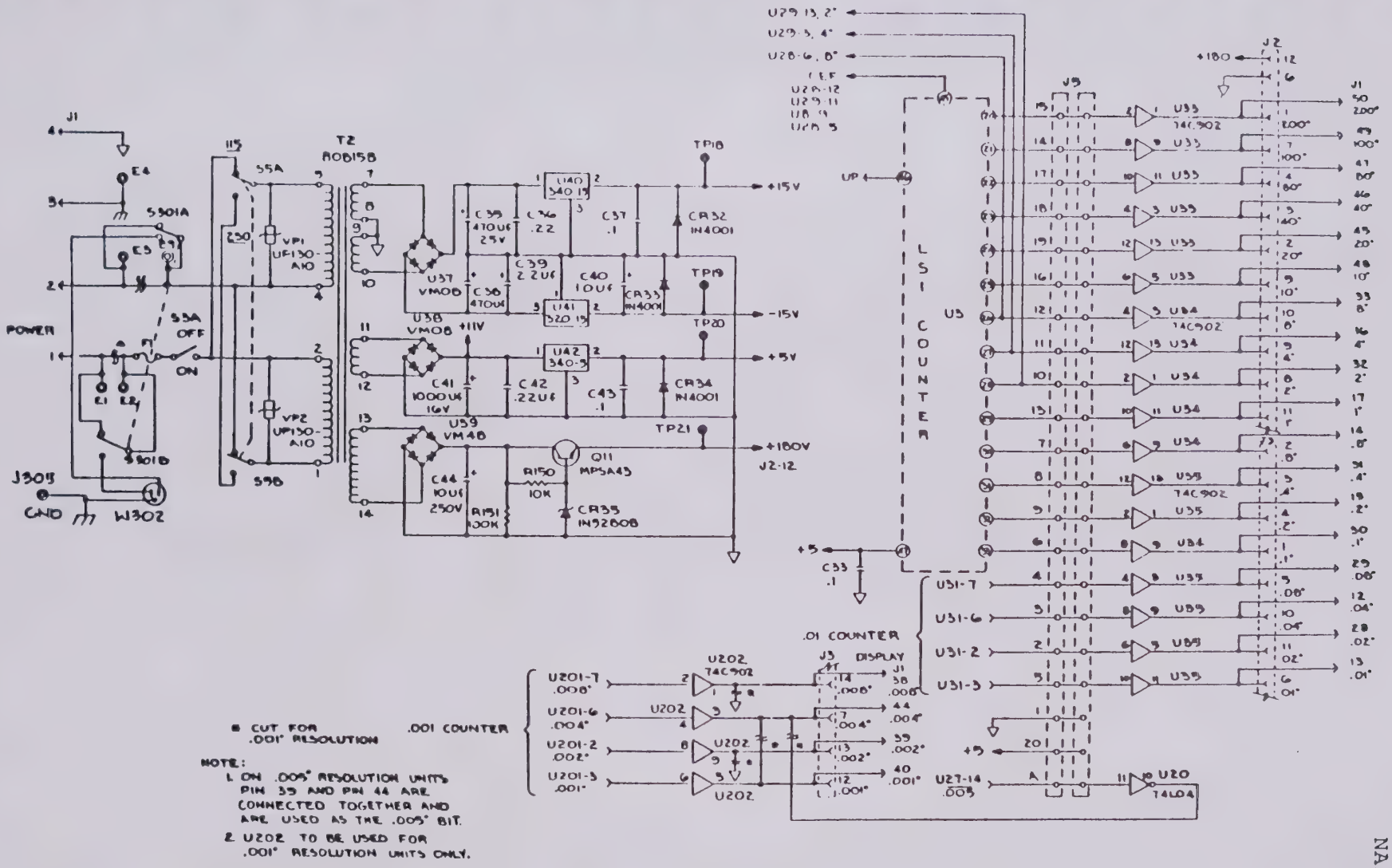


Figure 7-2. Main Chassis (Power Supply and Output Buffers) (783733) (Sheet 1 of 5), Schematic

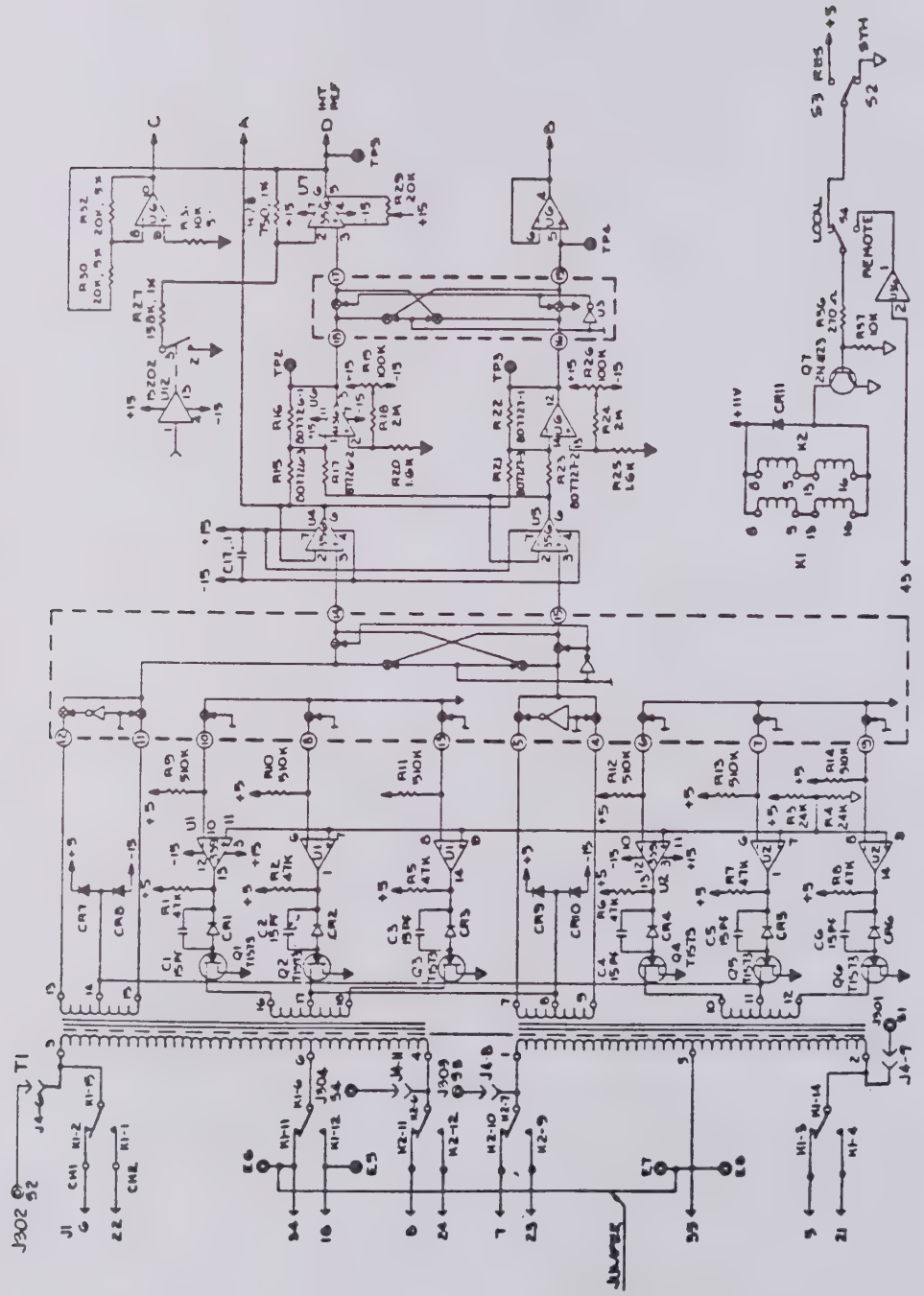


Figure 7-2. Main Chassis (Coarse Bridge and Precision Reference Generator)(783733)
(Sheet 2 of 5), Schematic

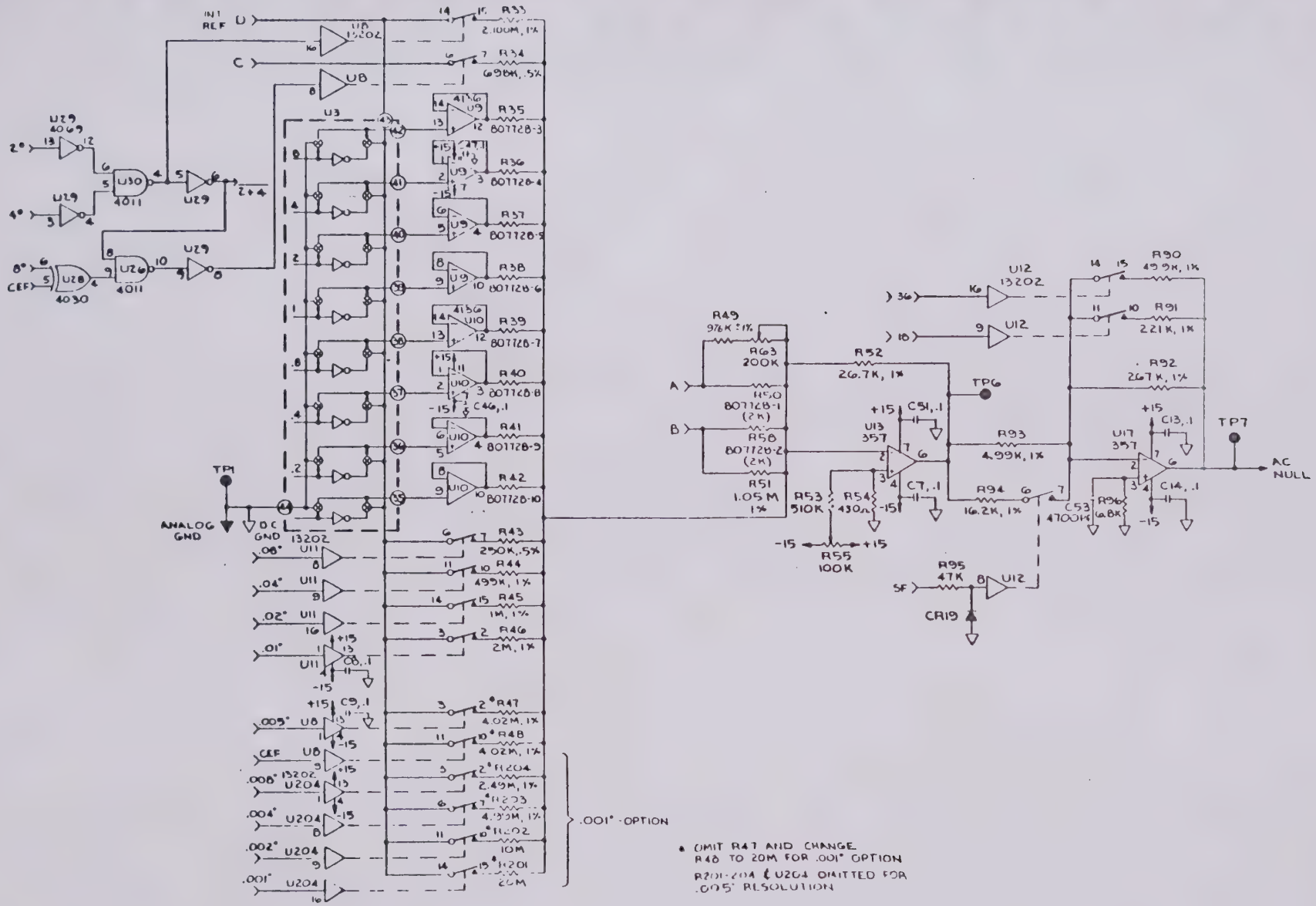


Figure 7-2. Main Chassis (Interpolation Ladder, Summing Amplifier and ac Amplifier) (783733) (Sheet 3 of 5), Schematic

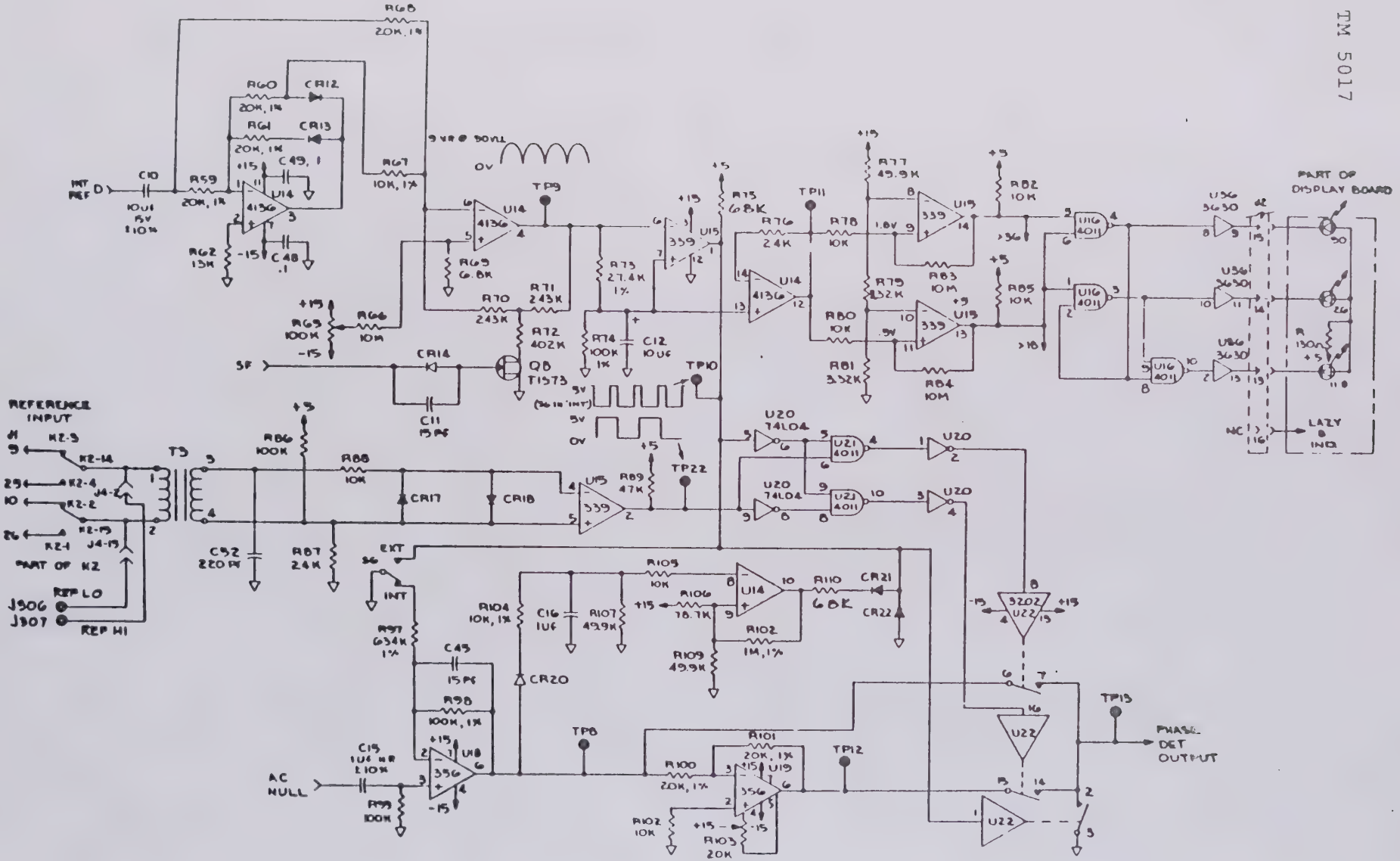
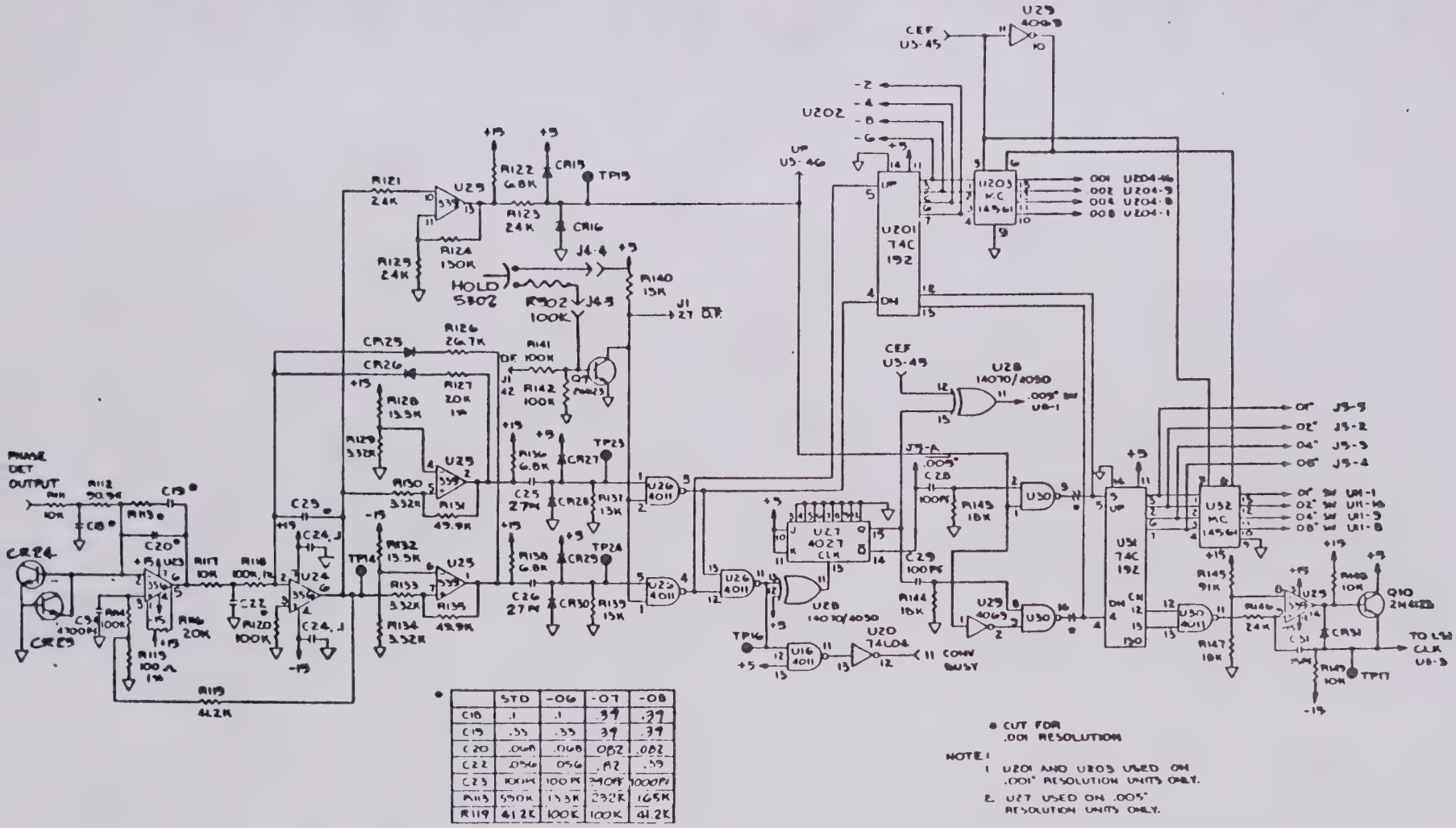
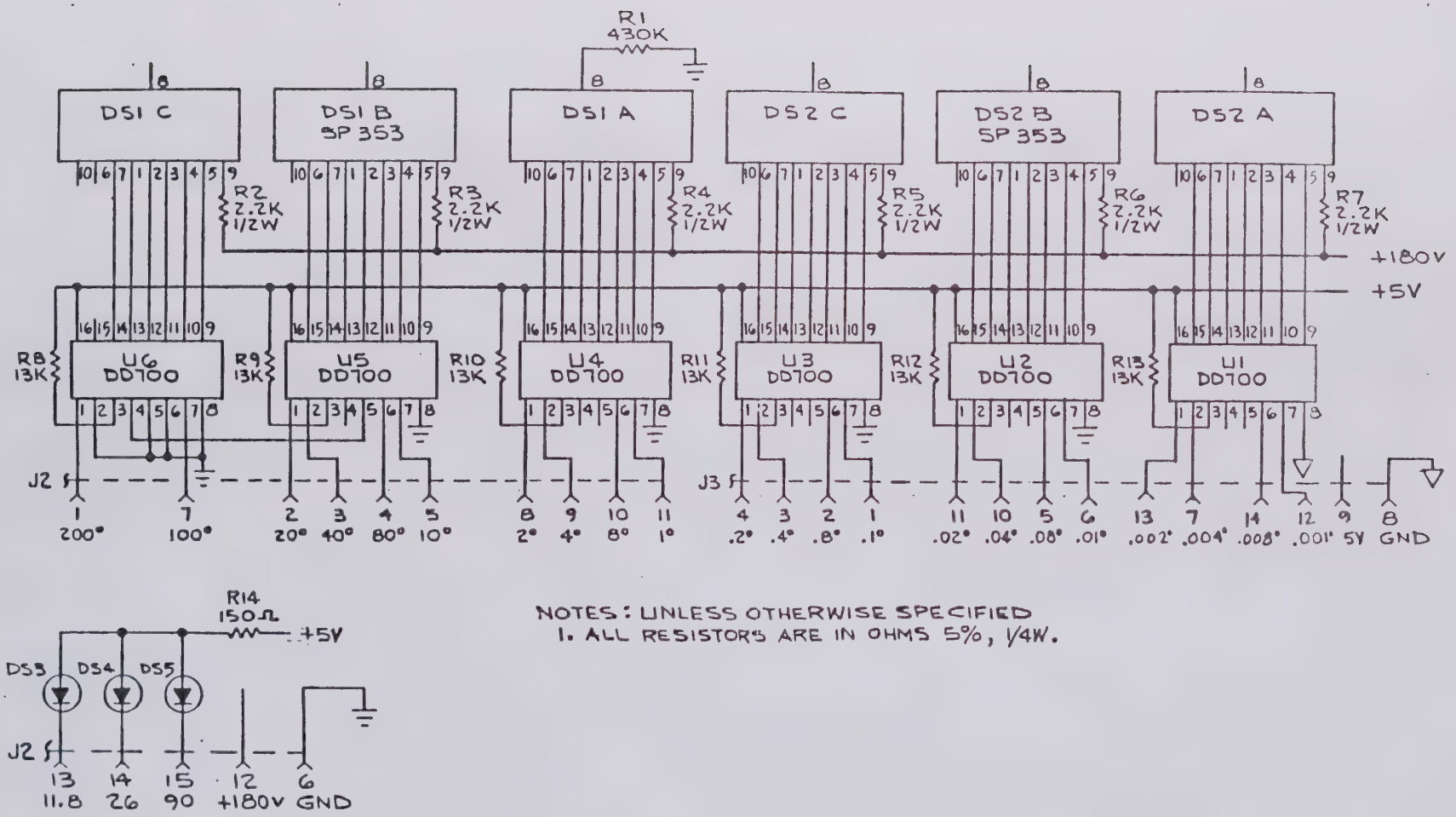


Figure 7-2. Main Chassis (Phase Detector and Internal Reference Circuit) (783733) (Sheet 4 of 5), Schematic



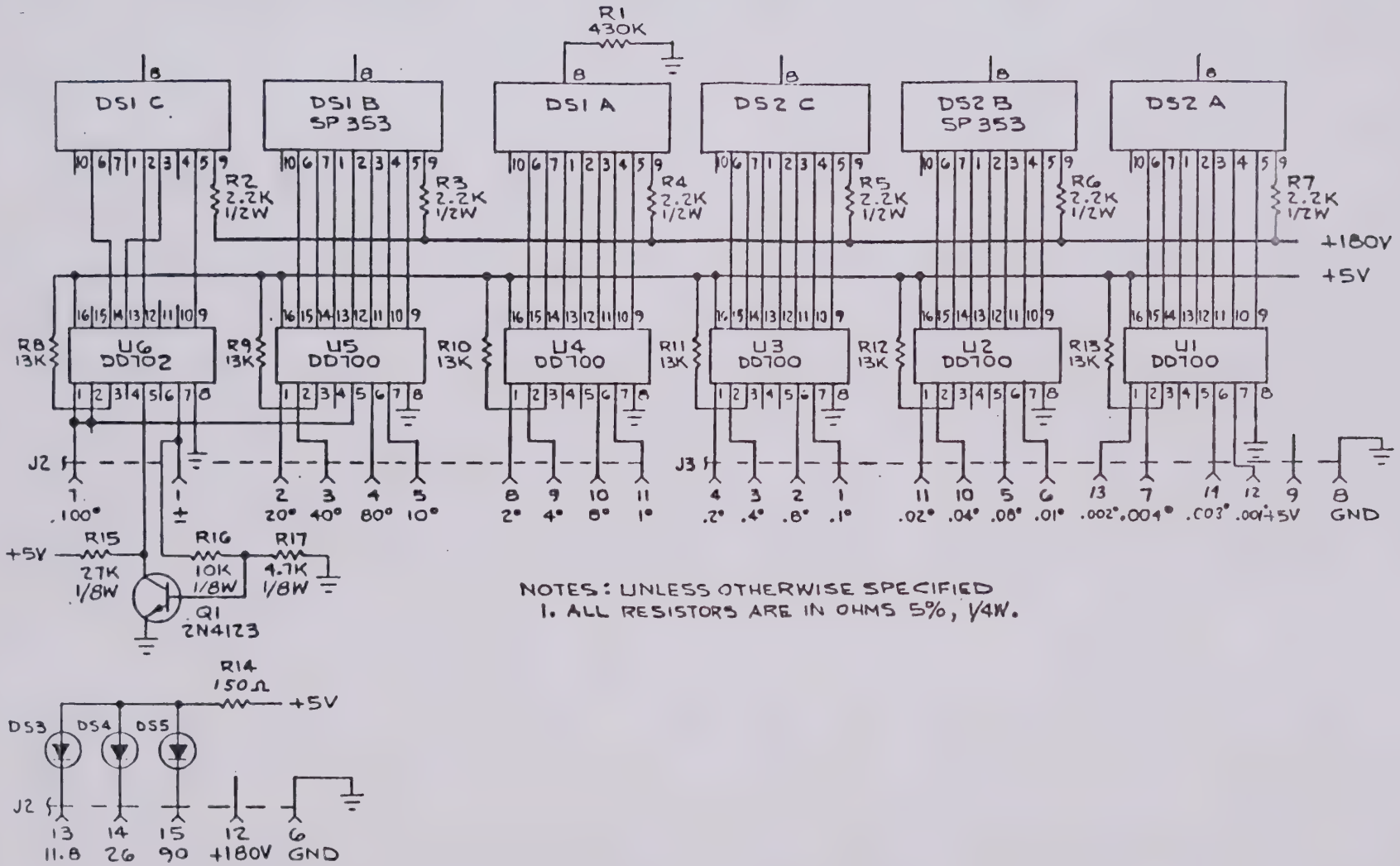
	STD	-06	-07	-08
C18	.1	.1	.39	.39
C19	.33	.33	.39	.39
C20	.068	.068	.082	.082
C22	.056	.056	.12	.33
C23	100PF	100 PF	240PF	1000PF
R113	550K	133K	232K	165K
R119	41.2K	100K	100K	41.2K

Figure 7-2. Main Chassis (First Integrator, VCO - Second Integrator and Counters) (783733) (Sheet 5 of 5), Schematic



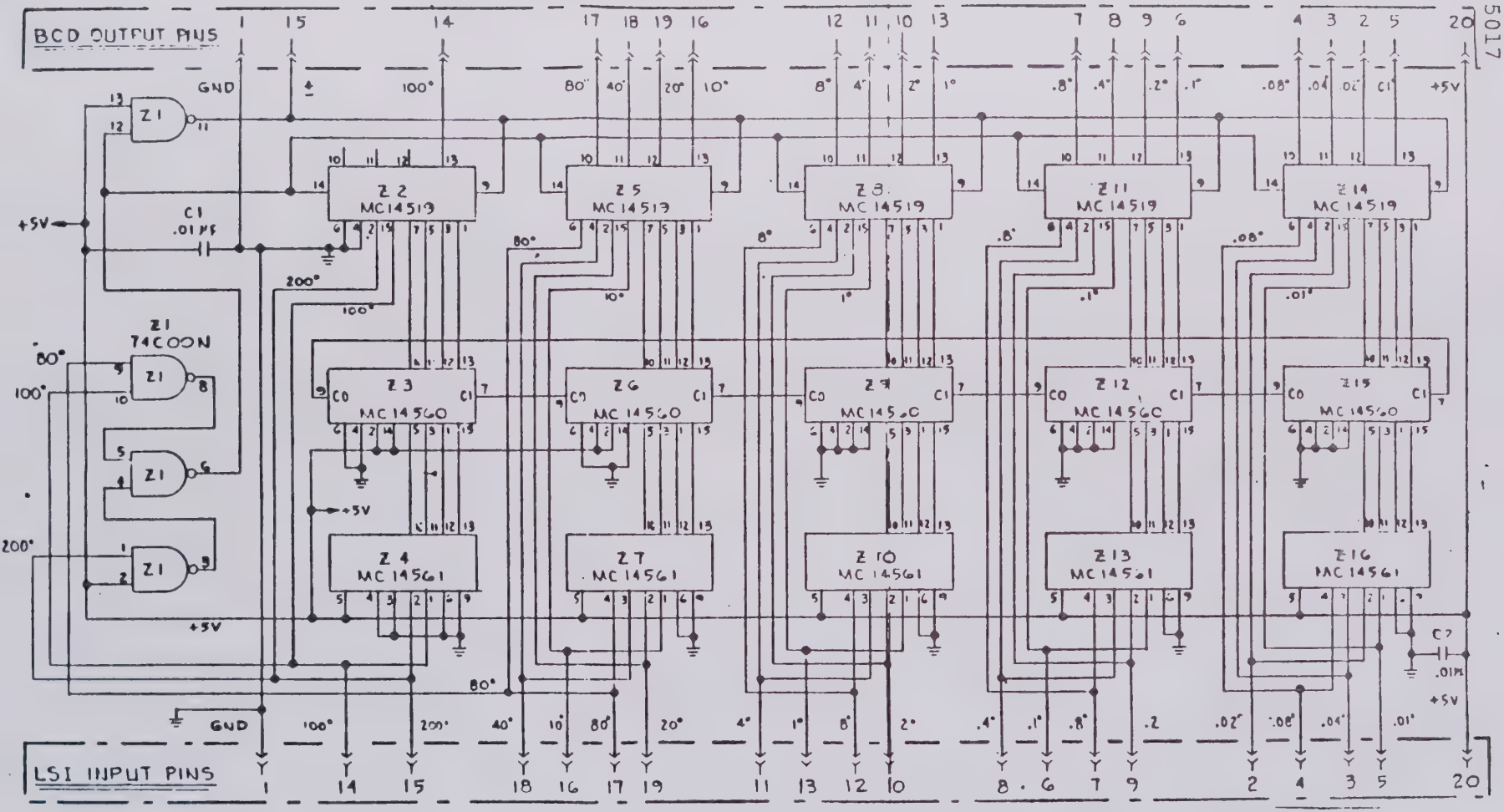
NOTES: UNLESS OTHERWISE SPECIFIED
1. ALL RESISTORS ARE IN OHMS 5%, 1/4W.

Figure 7-3. 360° Display Board, Schematic



NOTES: UNLESS OTHERWISE SPECIFIED
1. ALL RESISTORS ARE IN OHMS 5%, 1/4W.

Figure 7-4. ±180° Display Board (Standard), Schematic



NOTE:
1- Z1 (74C00N), AND Z 4, 7, 10, 13 AND 16 (MC14561) ARE 14 PIN IC' WITH PIN 7 TO GND AND PIN 14 TO +5V.
2- Z2, 3, 5, 6, 8, 9, 11, 12, 14, AND 15 ARE 16 PIN IC' WITH PIN 8 TO GND AND PIN 16 TO +5V.
3- THIS SHEET IS FOR P.C.B. 205745 "NO" REV.

Figure 7-5. ±180° Digital Board (Standard), Schematic

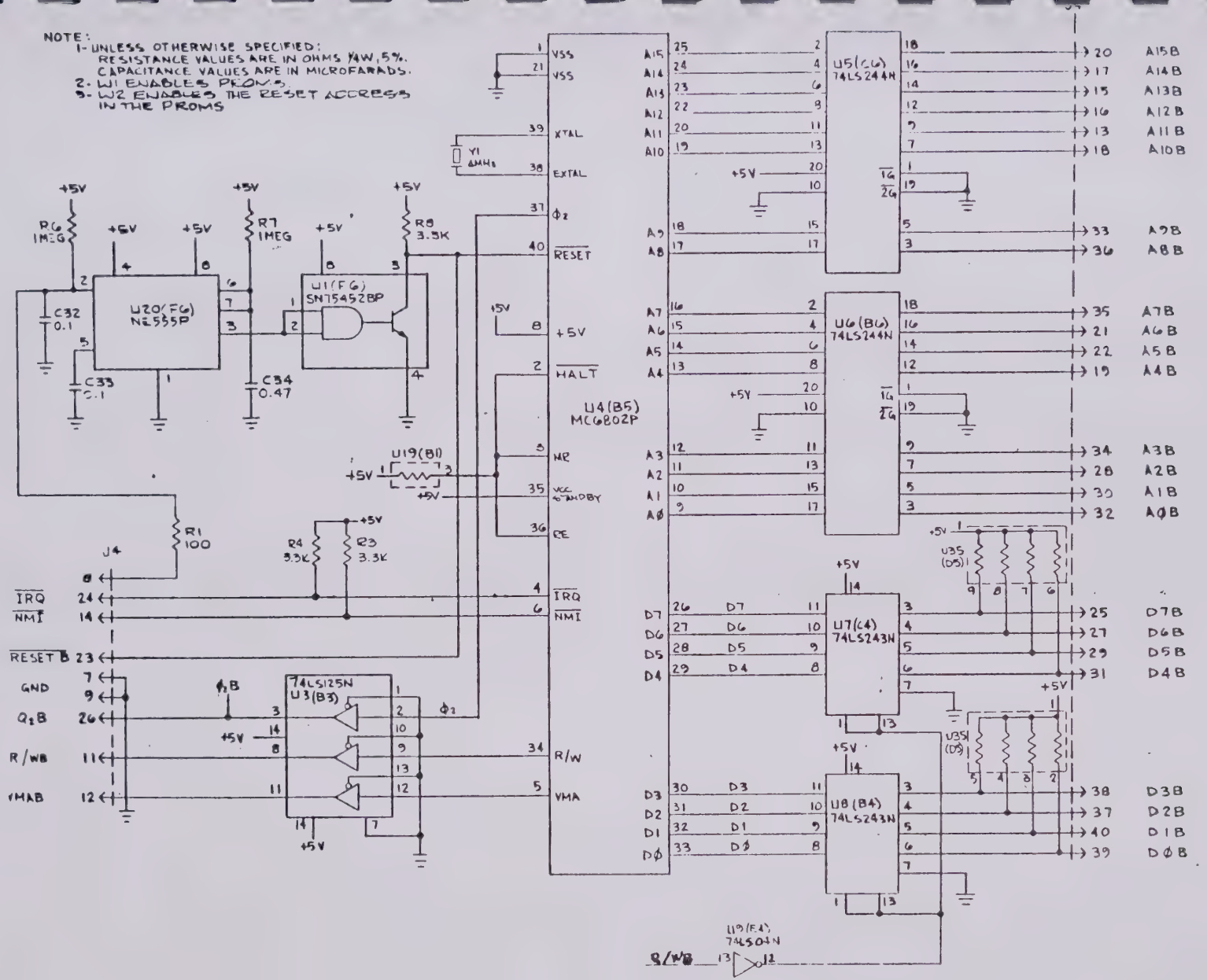


Figure 7-6. IEEE Interface Board (Sheet 1 of 4), Schematic (783777-02)

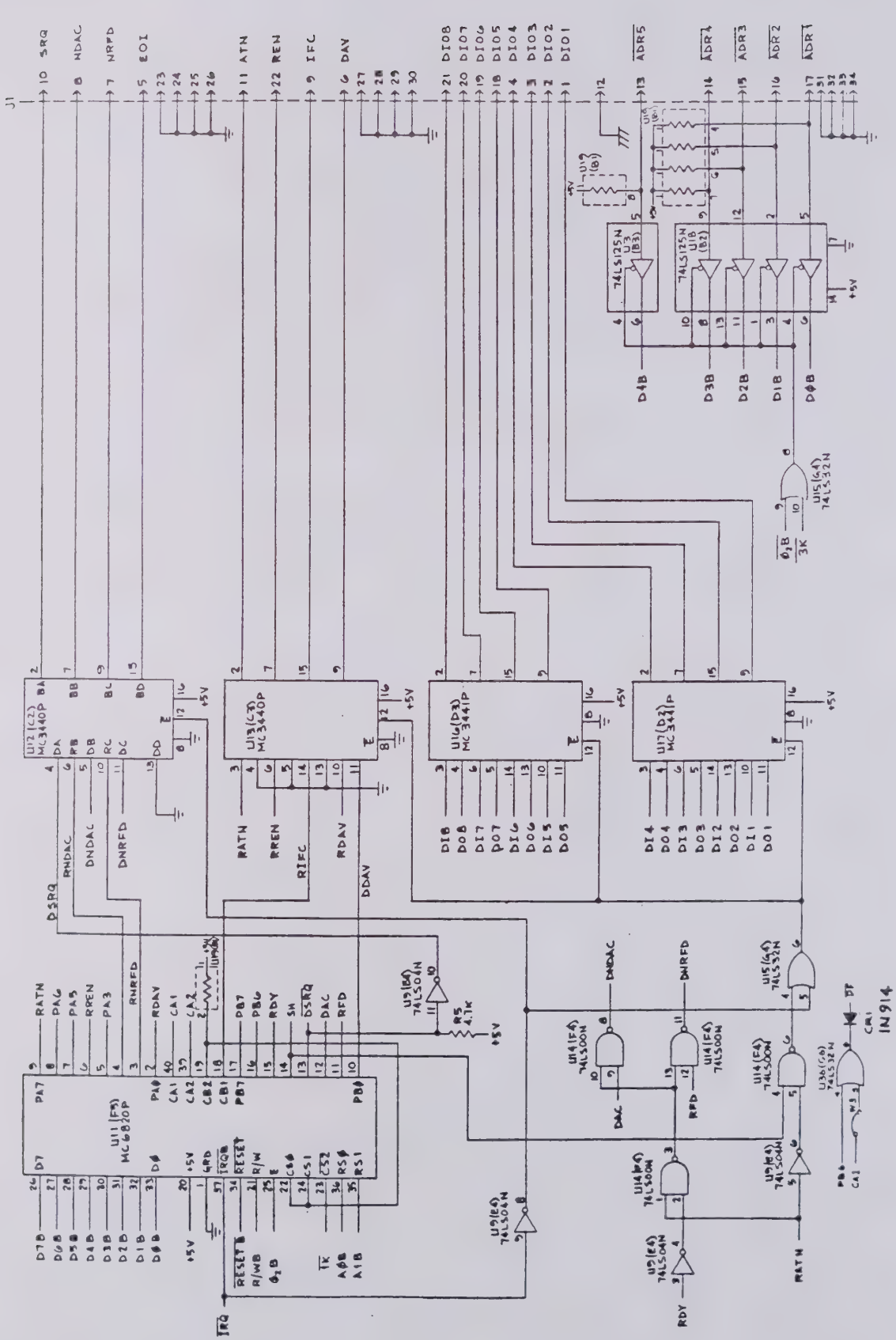


Figure 7-6. IEEE Interface Board (Sheet 2 of 4), Schematic (783777-02)

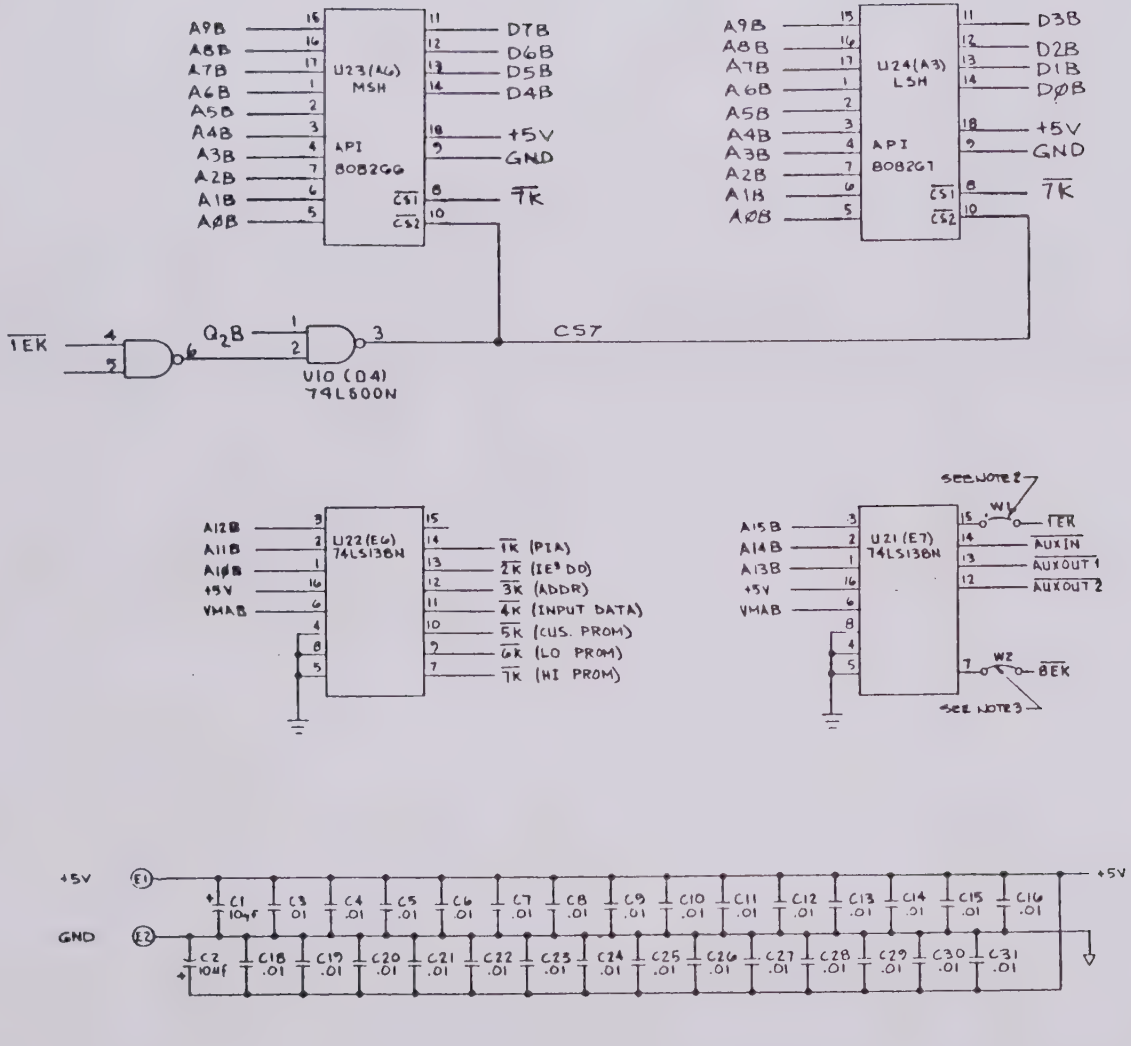


Figure 7-6. IEEE Interface Board (Sheet 3 of 4), Schematic (783777-02)

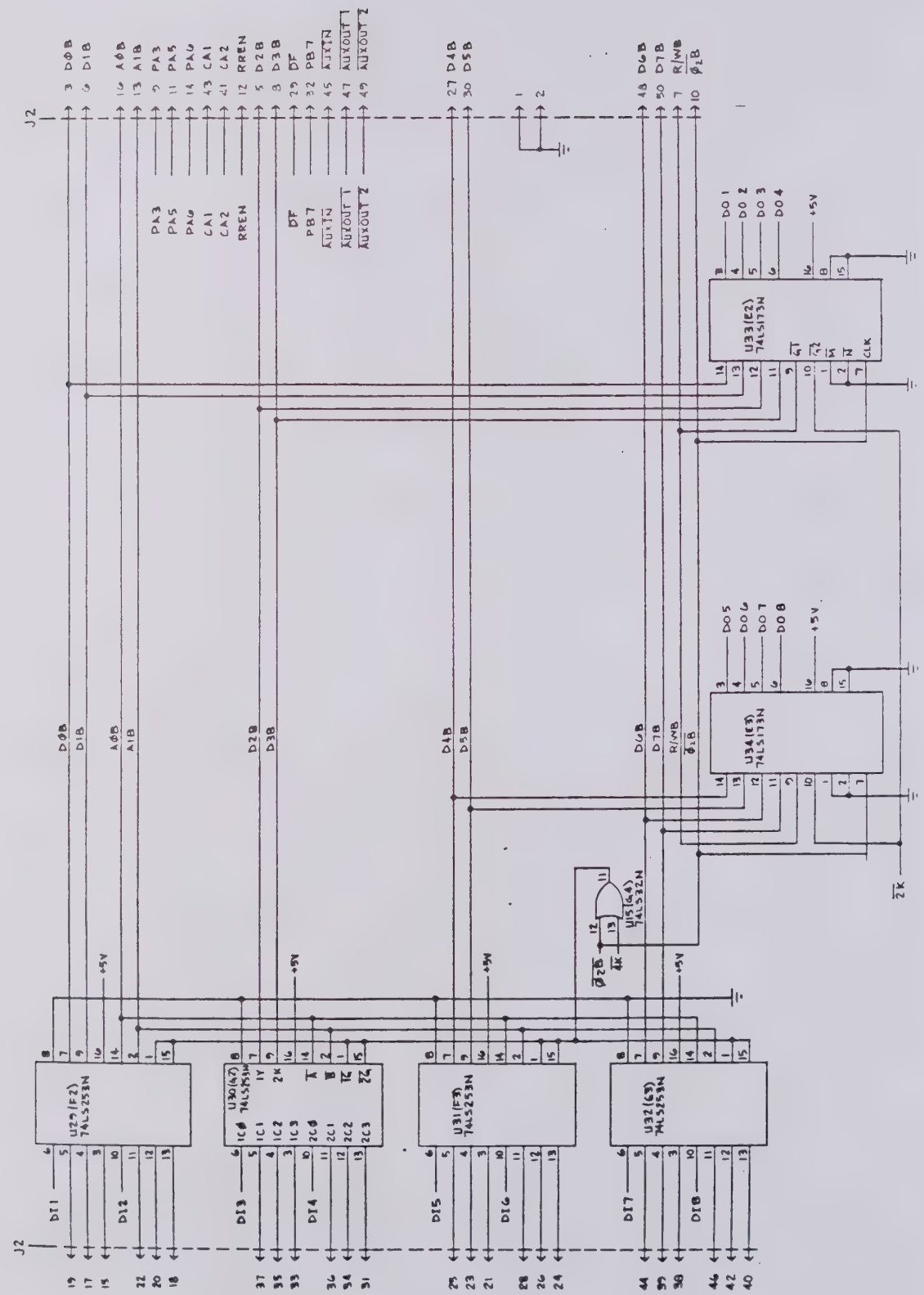
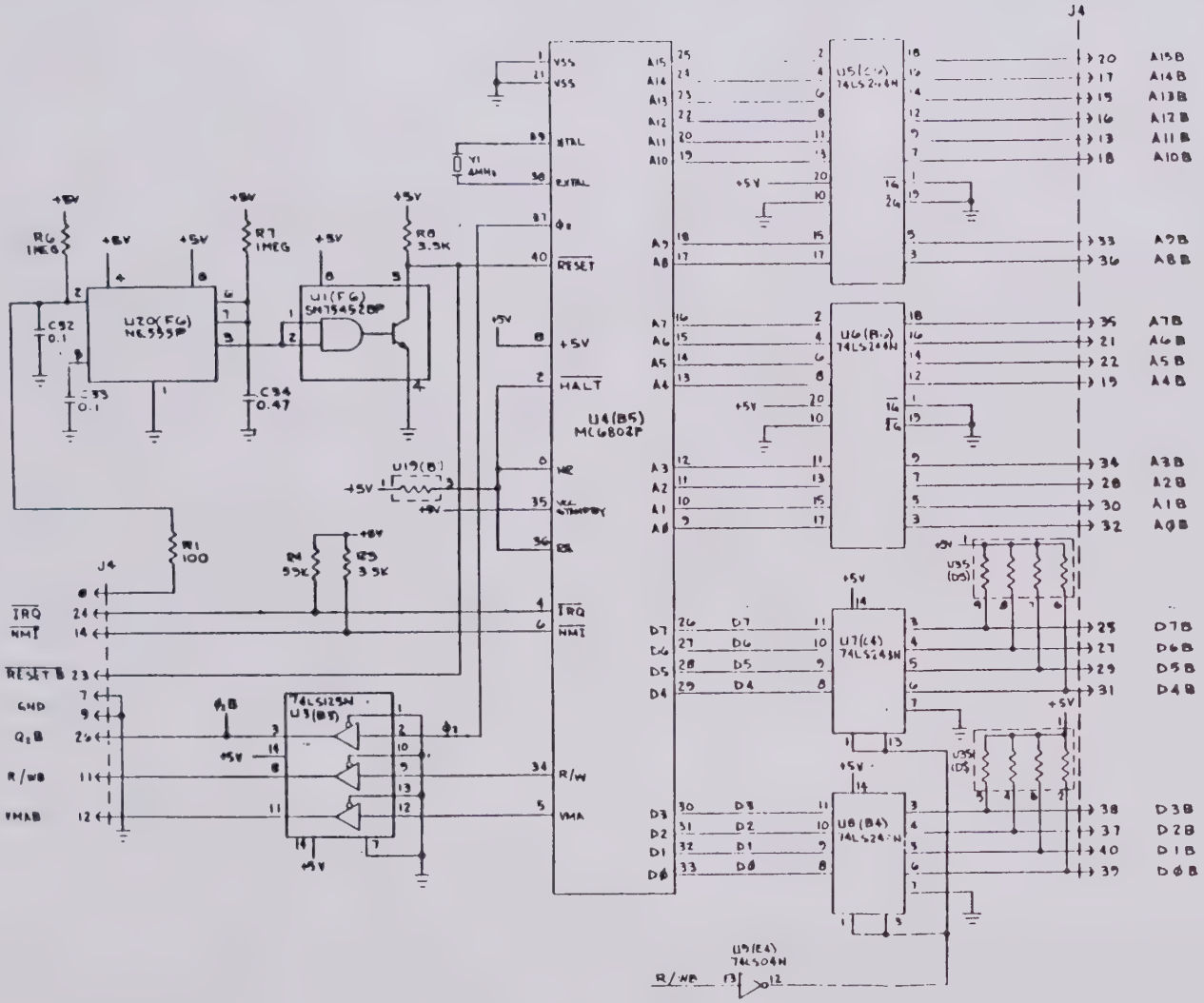


Figure 7-6. IEEE Interface Board (Sheet 4 of 4), Schematic (783777-02)



NOTE:
1- UNLESS OTHERWISE SPECIFIED: RESISTANCE VALUES ARE IN OHMS, 1/4W, 5%. CAPACITANCE VALUES ARE IN MICROFARADS
2- W1 ENABLES PROMS
3- W2 ENABLES THE RESET ADDRESS IN THE PROMS
4- USE W3 WITH API
5- USE W4 WITH DMA
6- DIODE CR1, SHEET 2, ZONE A7 USED ONLY WITH ASSEMBLY D 783777-04
7 GROUND AND VCC PAGE CHART

IC #	TYPE	+5	GND
U1	SN76452N	8	4
U3,18	74LS125N	14	7
U4	MC6802P	8	1,21
U5,U6	74LS244N	20	10
U7,U8	74LS245N	20	10
U9	74LS04N	14	7
U10,14	74LS00N	14	7
U11	MC6820P	20	1
U12,U16	MC3440P	16	8
U13,U32	74LS32N	14	7
U15,U17	MC3441P	16	8
U20	NE555P	8	1
U21,U22	74LS138N	16	8
U23,U29	LL16	20	10
U28,31	74LS393N	16	8
U33,34	74LS74N	14	7

Figure 7-7. IEEE Interface (783777-04), Schematic (Sheet 1 of 3)

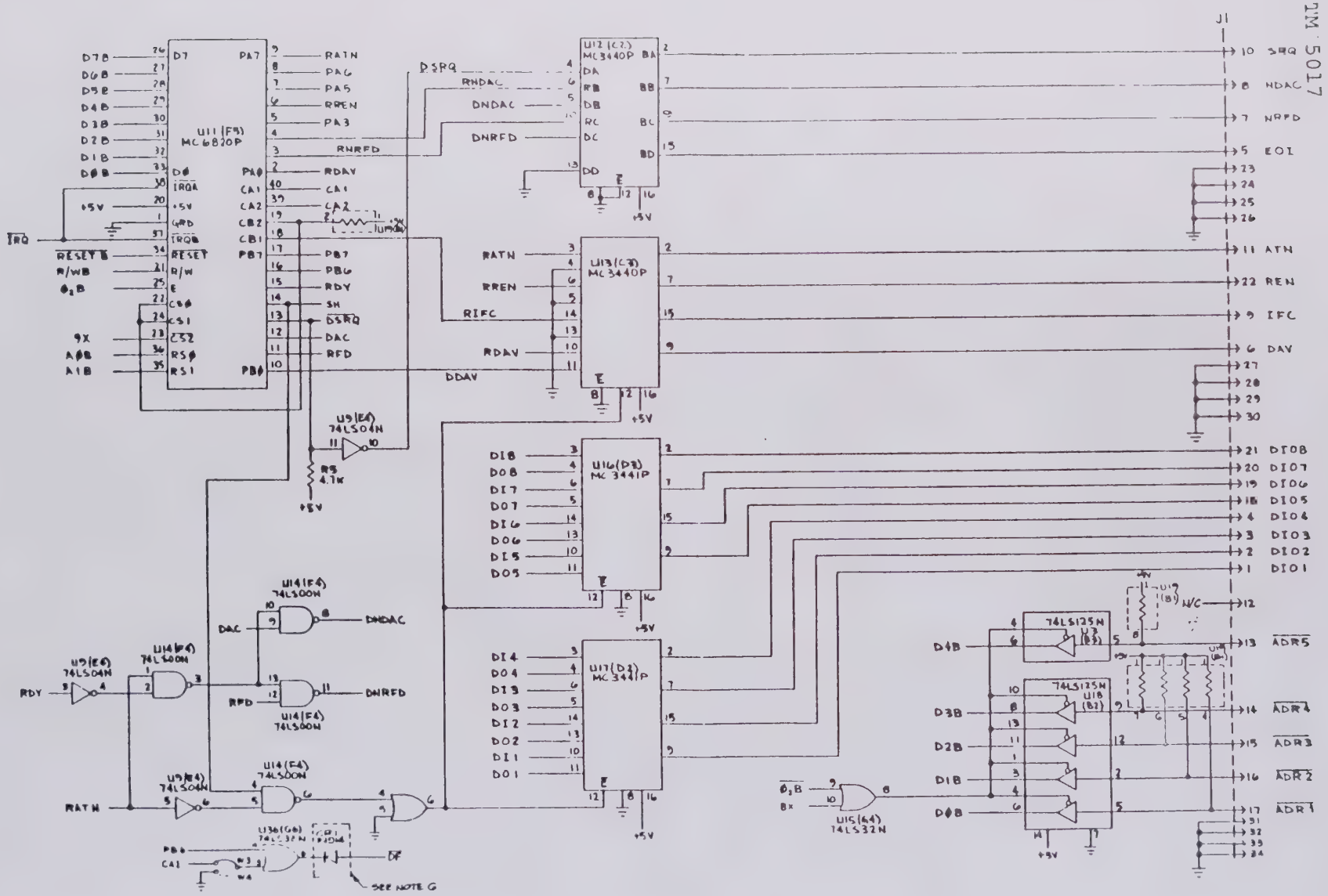


Figure 7-7. IEEE Interface (783777-04), Schematic (Sheet 2 of 3)

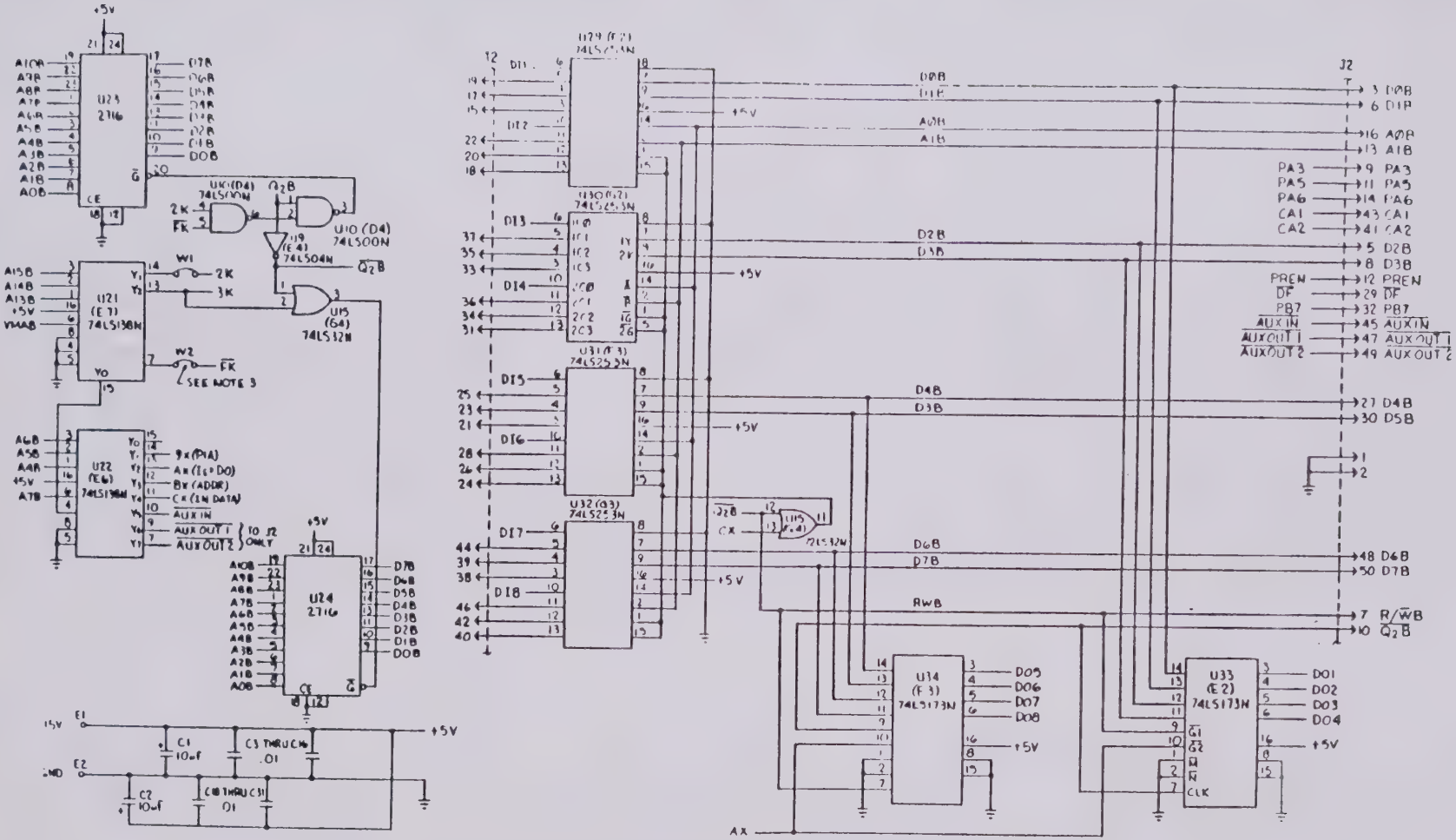


Figure 7-7. IEEE Interface (783777-04), Schematic (Sheet 3 of 3)

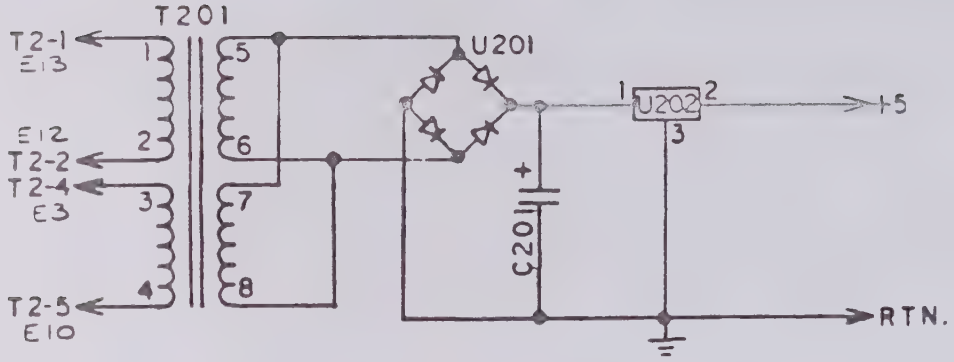


Figure 7-8. IEEE Interface Power Supply, Schematic

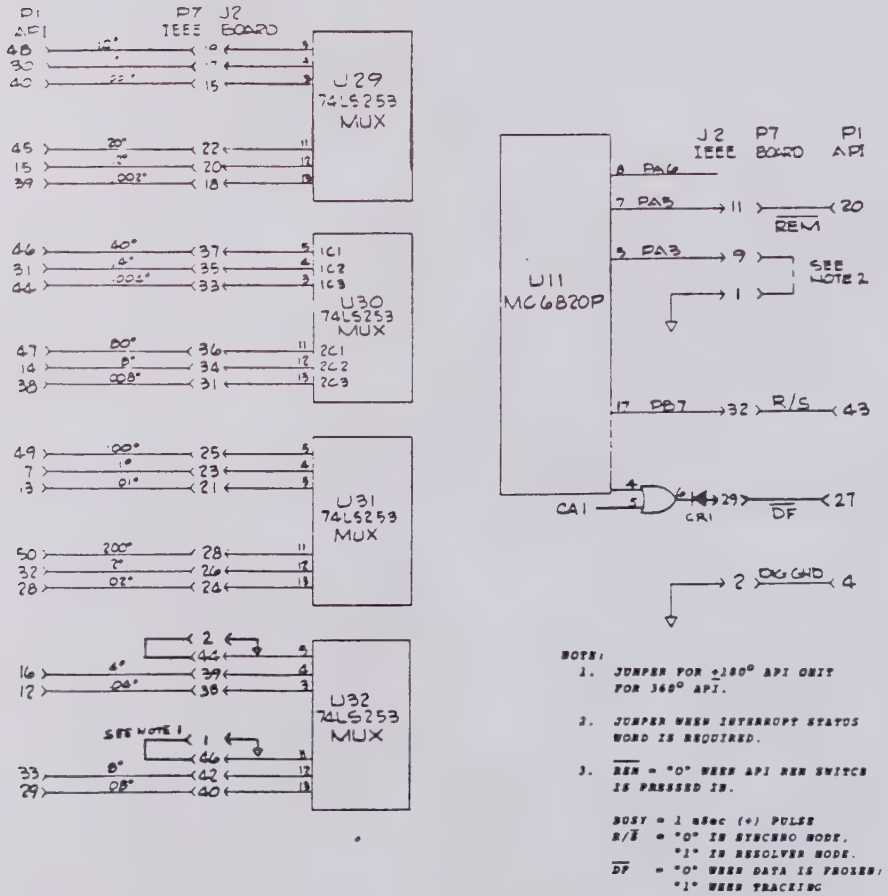


Figure 7-9. Interconnections Between IEEE Interface and API

APPENDIX A

MANUAL CHANGE DATA

A.1 INTRODUCTION

This appendix contains information necessary to backdate the manual to conform with earlier assembly configurations. To identify the configuration of the assembly used in your unit, refer to the revision letter on the solder side of each assembly. Table A-1 defines the assembly revision levels documented in this manual with an X.

A.2 NEWER UNITS

As changes and improvements are made to the unit they are identified by incrementing the revision letter or number marked on the affected assembly. These changes are documented on a Product Revision Sheet which, when applicable, is inserted at the front of the manual.

A.3 OLDER UNITS

To backdate this manual to conform with earlier assembly revision levels, perform the changes indicated in table A-1 in descending order.

Table A-1. Manual Status and Backdating Information

Assembly Name	NAI Part No.	To adapt manual to earlier rev configurations perform change numbers in descending order (by no.), ending with change under desired rev letter.								
		-	A	A1	B	B1	C	E	L	L1
Chassis Assembly	783784							1	4	X
360° Display Bd.	783739			3			X			
±180° Display	783747	X								
±180° Digital	783719		X							
IEEE Interface	783777-02				2	X				
IEEE Interface	783777-04						X			

X=the assembly revision levels documented in this manual.
Numbers represent changes described in the following pages.

CHANGE 1 - CHASSIS ASSEMBLY 783784 (PCR 22334)

In the chassis assembly parts list, change CR22 from NAI P/N 808974 to NAI P/N 883449 (1N4148).

CHANGE 2 - IEEE INTERFACE (PRIME) BOARD (PCR22460)

In the IEEE interface (prime board) parts list, change U23 and U24 from NAI P/N 886064-1 and -2 to 808266-02 and 808267-02 respectively.

CHANGE 3 - 360° DISPLAY BOARD 783739 (PCR 22538)

In the 360° display board parts list, change R8 through R13 from NAI P/N 880094 to NAI P/N 802186 and R14 from NAI P/N 880200 to NAI P/N 803672.

CHANGE 4 - MAIN CHASSIS 783784 (PCR 22762)

In the chassis assembly parts list, change C44 from NAI P/N 885188 to NAI P/N 808189.

WARRANTY

A. The seller warrants products against defects in material and workmanship for one year from the date of original shipment. The seller's liability is limited to the repair or replacement of products which prove to be defective during the warranty period. There is no charge under the warranty except for transportation charges. The purchaser shall be responsible for products shipped until received by the seller.

B. The seller specifically excludes from the warranty 1) calibration, 2) fuses, and 3) normal mechanical wear, e.g.: end-of-life on assemblies such as switches, relays, gear trains, etc. is dependent upon number of operations or hours of use, and end-of-life may occur within the warranty period.

C. The seller is not liable for consequential damages or for any injury or damage to persons or property resulting from the operation or application of products.

D. The warranty is voided if there is evidence that products have been operated beyond their design range, improperly installed, improperly maintained or physically mistreated.

E. The seller reserves the right to make changes and improvements to products without any liability for incorporating such changes or improvements in any products previously sold, or for any notification to the purchaser prior to shipment. In the event the purchaser should require subsequently manufactured lots to be identical to those covered by this quotation, the seller will, upon written request, provide a quotation upon a change control program.

F. No other warranty expressed or implied is offered by the seller other than the foregoing.

CLAIMS FOR DAMAGE IN SHIPMENT

The purchaser should inspect and functionally test the product(s) in accordance with the instruction manual as soon as it is received. If the product is damaged in any way, including concealed damage, a claim should be filed immediately with the carrier, or if insured separately, with the purchaser's insurance company.

SHIPPING

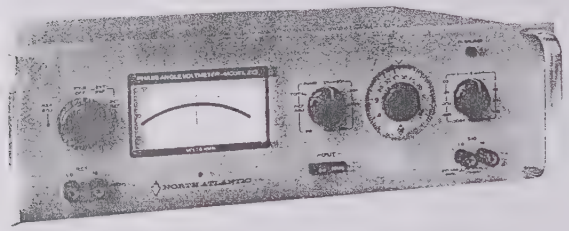
On products to be returned under warranty, await receipt of shipping instructions then forward the instrument prepaid to the destination indicated. The original shipping containers with their appropriate blocking and isolating material is the preferred method of packaging. Any other suitably strong container may be used providing the product is wrapped in a sealed plastic bag and surrounded with at least four inches of shock absorbing material to cushion firmly, preventing movement inside the container.

north atlantic

AC and Synchro Instrumentation

NALOG PHASE ANGLE OLTMETERS

: multifunctional instruments combine phase-sensitive modes with nctions of a conventional AC voltmeter operating over the range of 10 100 kHz. They provide direct-reading voltage measurement of the total, mental, in-phase and quadrature components of an AC signal to 2% :ale, as well as phase angle to 0.5°. They feature calibrated voltage s of 300μV (or 1mV) to 300V rms full scale, excellent harmonic rejec- ıigh-quadrature overload capability, and operation with a wide range of nce voltages.



el 213C Phase Angle Voltmeter

Model 213C Phase Angle Voltmeter is designed to replace the well- n Model VM-202 and 212 Phase Angle Voltmeters.

rates as a conventional voltmeter from 10 Hz to 100 kHz, and when in the fundamental and phase-sensitive modes operates at a single ecified frequency within the range of 30 Hz to 10 kHz with a 5% band- Both signal and reference inputs are isolated. Voltage accuracy is : phase angle accuracy is ±1°.

ting simplicity is a highlight of the 213C, allowing for complex AC sis using large, easy-to-read controls and meter movement. The har- rejection capability insures rated phase angle measurement ac- / when the signal and/or reference contains harmonics. This feature is ularly desirable for accurate measurement of inductive components as transformers, synchros, and resolvers, that inherently contain odd- harmonics.

l 321 Broadband Phase Angle Voltmeter

odel 321 combines in one instrument, a phase sensitive null detector, e sensitive voltmeter and a phase meter, operating over the frequency of 10 Hz to 100 kHz. It s broadband characteristics make it ideally for use in amplifier and network design, vibration analysis, telemetry n measurements, bio-medical research, and similar applications re- g the measurement of complex signals and their vector components broad range of frequencies. Voltage accuracy is ±2%; phase angle acy is ±0.5° (mid-band).

odel 321 incorporates proprietary circuit techniques that eliminate e of reactive phase shifters and filters while maintaining accuracy, ty, and greater than 40 db harmonic rejection. In addition to phase total, fundamental, in-phase and quadrature voltages can be red with respect to an arbitrary phase-shifted reference. The nce can vary from 150mV to 150V without the need for calibration or ment. The 321's versatility, accuracy, and ease of use make it ideally for both laboratory and production line use.

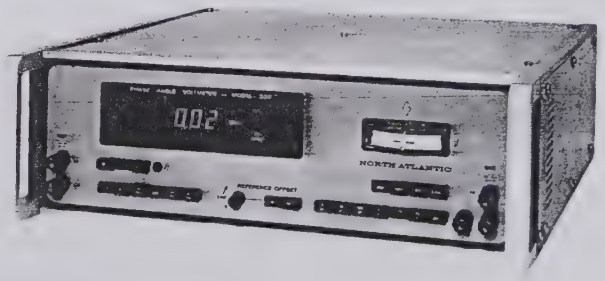
DIGITAL ANALYZING VOLTMETERS

Model 2250 Digital Analyzing Voltmeter

The Model 2250 feature signal analysis capabilities never previously offered in an AC Analyzer. Using Fast Fourier Transform Techniques while operating over its 10 Hz to 100 KHz range, the Model 2250 is 68000 micro-processor-based instrument which provides the traditional measurements of Total, Fundamental, In Phase, Quadrature, and Phase Angle. Waveform analysis capabilities also include THD, individual harmonic, and ratio measurement. Autoranging, a zero center scale null meter, front panel keypad, and IEEE-488 GPIB are standard. The front panel annunciators indicate when an overload condition exists, the data displayed is modified by one or more Offset functions, and when the input signal is outside the bandwidth of a manually selected frequency. Typical phase accuracy is 0.05°. Voltage accuracy typically is 0.05% of reading + 0.05% F.S. The Model 2250's multiple features make this instrument the ideal AC Analyzer for laboratory, test, and repair facilities.

DIGITAL PHASE ANGLE VOLTMETERS

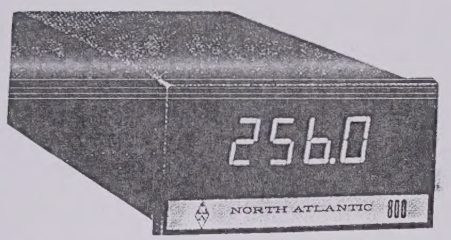
This series of instruments provides the digital equivalent of the well known Phase Angle Voltmeter, but with significant increases in both precision and speed of measurement. Voltage measurements include total, fundamental, in-phase, and quadrature. Phase measurements are from 0° to 359.9°, and a +/−45° reference offset control is provided. Full-scale voltage ranges (10mV to 500V) and phase angle (359.9°) are directly read on a 4-½ digit display. Voltage ranges may be pushbutton selected or auto-ranged. All models provide for both manual and remote programming or optional 488 IB (IEEE-STD-488-1978) interface bus. Digital outputs include reading, mode, range and polarity information as well as data status signals. Longterm use of this instrument series is assured since field-change of frequency plug-in modules requires only a routine recalibration procedure.



Model 225
Digital Phase Angle Voltmeter

Designed for multi-frequency applications, the Model 225 is available with 1, 2, 3, or 4 pre-specified plug-in frequency modules (30Hz to 54kHz). They feature pushbutton selection of voltage range (or auto-range), measurement mode and frequency range. Voltage accuracy is 0.05% and phase accuracy is 0.2°. Local/remote pushbutton selection permits remote programming of all functions for ATE use. Broadband signal isolation features 10M input impedance. A standard null meter is included for applications such as synchro nulling (full-scale adjust is an option).

SYNCHRO PANEL METERS



Model 800
Synchro Panel Meter

The new Model 800 Synchro Panel Meter reaches a new level in the price/performance balance of synchro angle indicators. Designed for system or test set applications, the Model 800 features 0.1° resolution and operates directly off the stator and rotor signals, requiring no separate power. With its Type II tracking loop, the Synchro Panel Meter has full digital output and is available with 0 to 359.9, ± 179.9 and a fully variable range. It has ±2° offset adjust to allow for final system zeroing without the sometimes difficult task of physically "tweaking in" a remote synchro. Pin programming for all standard synchro or resolver signals offers maximum user flexibility.

With option 9999, the Model 800 can be user programmed, via internal DIP switches or open collector logic, for 0 to any positive four digit full scale value desired. This user programming allows a common device to be used in different systems requiring various full scale values (i.e., batch weighing, rod position, level control, etc.)

Model 801
Synchro Panel Meter

North Atlantic's broad experience in advanced syncho/resolver instrumentation has resulted in the development of the Model 801 five-digit Synchro Panel Meter. The Model 801 combines the reliability and small size of North Atlantic's Model 800 Synchro Panel Meter with the high-accruacy and proven design concepts of the 8300/8800 series of Angle Position Indicators.

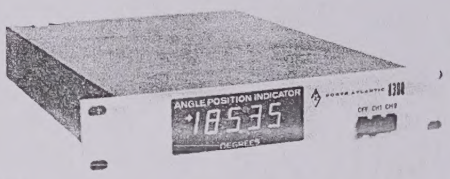
Intended for portable, system, or test set applications, the Model 801 has 0.01° resolution and can operate directly off the stator and rotor input signals, requiring no separate power. Standard accuracy is 0.05°; accuracy of 0.03° is also available. A broad frequency range of 47-1200 Hz and rear panel switch programming for all standard synchros and resolvers results in maximum versatility for the user.

The Model 801 uses a Type II tracking servo loop, which results in no tracking lag error up to its maximum tracking rate of 180°/s. The bright and very large 0.56" L.E.D. display allows easy readability even under the most difficult conditions. In addition, a tri-state five byte parallel B.C.D. output is available at the rear panel connector for remote use; a busy signal indicates when the Model 801's data is valid. This allows data transfer to a computer or other digital device without having to freeze the converter.

To aid in system zeroing, the Model 801 has a 2° offset adjust accessible at the rear. A display readout in degrees and minutes, rather than the standard degrees and decimal degrees, is also available.

A prime consideration in the circuit design of the Model 801 was reliability and maintainability. No sealed modules are used; all components are accessible and test points are provided for signal tracing.

ANGLE POSITION INDICATORS

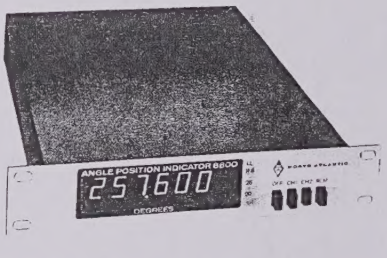


Model 8300
Angle Position Indicator

The Model 8300 offers a combination of LSI-enhanced reliability, low cost, and features never before available in any angle position indicator. The unit can be programmed for line-line, synchro/resolver mode via direct hard wire connection at the rear mating connector. Each of the two data channels may have independent references from 47Hz to 440Hz. Thus, one channel may read 11.8V, 400Hz resolver data and the other 90V, 60Hz synchro data. Absolute accuracy is .05° for data rates up to 5rps (1800°/second). Resolution is .01°. Digital outputs are 5-decade BCD data lines plus converter busy and data freeze lines. Options include degrees/minutes display, +/−180° display, higher accuracy (+0.03°) and high frequency (400-1200 Hz).

Model 8310-07
Angle Position Indicator

The Model 8310-07 is a bench top model of the 8300 featuring full front panel controls and input terminations, data freeze button, tilt stand and mounting ears for rack mounting (if desired). Its accuracy is ±0.03° over a frequency range of 47-440 Hz.



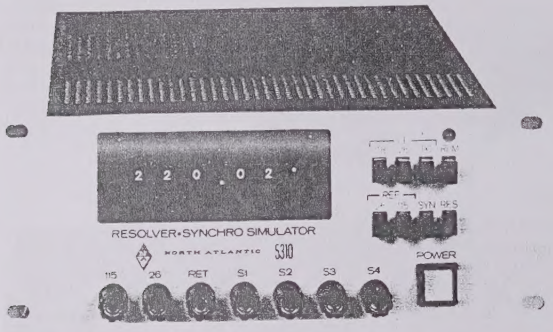
Model 8800
Angle Position Indicator

The Model 8800 is a growth version of the basic Model 8300 described above. Featuring a resolution of 0.001 and accuracy to 0.004°, the LSI based Model 8800 truly represents a major advance in synchro-to-digital converter technology. A full type II tracking servo, the 8800 tracks synchros at up to 200°/sec (standard; 1000°/sec optionally). Phase sensitive detection inherently rejects unwanted harmonics and noise contained in the incoming signal. Built-in auto-phase correction further reduces the possibility of errors caused by quadrature and harmonics when reference and signal are out of phase. The 8800 accepts any standard line-to-line level *without* preselecting or preprogramming the input signal. This unique feature is due to an auto-ranging circuit that displays the applied input signal voltage level on the front panel. Two pushbutton front-panel selectable input channels are provided. BCD outputs, data freeze and converter busy signals make the unit ideal for ATE application. The display is a bright, easy-to-read, 0.55" gas discharge planar display coupled with our exclusive LAZY-EIGHT ambiguity indicator (discerns between real 8's and 8's due to jitter).

Model 8810
Angle Position Indicator

The Model 8810 is a bench top version of the Model 8800 (above) featuring full front panel controls and input terminations, tilt stand and ears for rack mounting (if desired). Additionally, the Model 8810 is available with the 488 IB (IEEE STD 488-1978) interface bus for ATE applications.

:SOLVER/SYNCHRO
MULATORS & BRIDGES



l 5310

ammable Resolver/Synchro Simulator

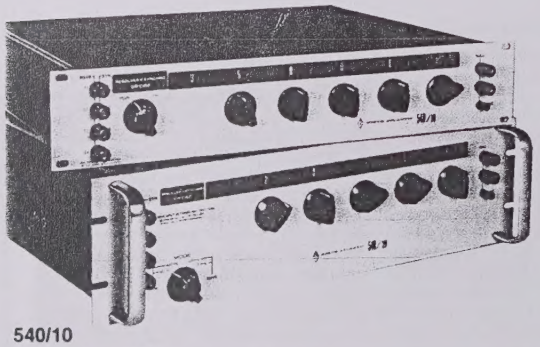
odel 5310 can be used as a bench-top Resolver/Synchro Simulator or ompletely programmable device for ATE systems. Designed to drive l-type synchros and resolvers, typical applications include produc- esting, simulation systems and general purpose automatic syn- solver testing. The 5310 replaces the previous series 538 Digital to er/Synchro Converters.

ned within the same compact package size as our popular series nd 8810 Angle Position Indicators, the 5310 features fully isolated in- nd outputs and is protected against accidental short circuits and ads on the output and overvoltage and transients on the power line in-

ard features include full remote programmability for line-to-line level, ice levels, synchro or resolver mode and output angle. Remote con- parallel BCD or binary bussable tri-state; IEEE-488-1978 GPIB is ble. The 5310 also has full front-panel controls for manual operation.

10 has been designed using state-of-the-art technology with reliabili- maintainability as major considerations. Serviceability is enhanced wide use of IC sockets.

ing 18 bit resolution, 3.0 VA output and 36 arc-second accuracy, the ideally suited for many commercial and military applications.



540/10

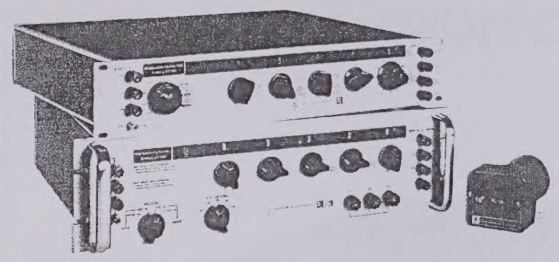
ver/Synchro Bridge

idge permits direct measurement of resolver and synchro transmit- features a constant null gradient output voltage, isolated input and and input impedance over 500K. The Model 540/10 features 2 arc- accuracy at 400Hz and is useful up to 10kHz.

540/20

band Resolver/Synchro Bridge

odel 540/20 features 10 arc-second accuracy over most of the frequen- d from 55Hz to 10kHz. Also featured is a constant null gradient which permits deviation measurements by using a Phase Angle ter as the null detector.



Series 530

Resolver/Synchro Simulator

This simulator provides the ideal outputs for driving resolvers and synchros at 11.8, 26, 90 and 115V line-line voltages. These line-line voltages are all available with either 26V or 115V, 400Hz excitation, and feature isolated input and output. Accuracy is 2 arc-seconds. Resolution is .0001°, with standard units 3½" full rack panel.

Model 530/20

Broadband Resolver/Synchro Simulator

The Model 530/20 features 10 arc-second accuracy at 60Hz, 400Hz, and 800Hz, and 20 arc-second accuracy at 10kHz. It is useable over the entire frequency band from 50Hz to 10kHz. This broadband frequency characteristic makes it an ideal instrument for test facilities desiring the maximum capability in each instrument.

Model 532

Low-Cost Synchro Simulator

Model 532 is a miniature synchro simulator offering precision performance in a small panel-mounted unit suitable for production test, ground support and similar systems. Direct simulation of 11.8V 400Hz line-line synchro transmitters (CX) is provided, with dial reading in 30° segments plus 5° increments selectable by sealed thumbwheel switches and accurate to 30 arc-seconds.

TECHNICAL BULLETINS

North Atlantic publishes a series of technical bulletins dealing with theoretical design and application aspects of instrumentation. Copies are available without charge from our Sales Department or from any North Atlantic Sales Engineering Representative.

NO. 112 CONVERTING MOTION TO DIGITAL DATA
NO. 113 SERVO-STYLE CIRCUIT SPEEDS SYNCHRO-TO-DIGITAL CONVERSION
NO. 117 SYNCHRO/RESOLVER-TO-DIGITAL CONVERSION FOR COMPUTER INTERFACE
NO. 120 PHASE ANGLE VOLTMETERS
NO. 121 ANGLE-SENSING TRANSDUCERS FOR SHAFT-TO-DIGITAL CONVERSION

SALES OFFICES

North Atlantic Sales Engineering Representatives are located in principal cities throughout the world. These representatives are available for consultation, can provide engineering data on any of the North Atlantic products, or prepare technical and cost proposals for special requirements on computer interface equipment, phase sensitive instrumentation, resolver/synchro instrumentation and automatic test equipment. To locate the Sales Engineering Representative serving your area, please consult the current editions of EEM (Electronic Engineers Master), or contact our Sales Department.

SERVICE CENTERS

Factory service is available at authorized Service Centers in:

LOS ANGELES, CA
MINNEAPOLIS, MN
HAUPPAUGE,NY
LONDON, ENGLAND
MUNICH, GERMANY
PARIS, FRANCE
TEL AVIV, ISRAEL
TOKYO, JAPAN

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